

# Climate Forecasting for Wind Energy

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Nube Gonzalez-Reviriego, Verónica Torralba Fernandez**

EWEA workshop, March 12<sup>th</sup> 2014, Barcelona



**If I could tell you the  
average wind conditions for the  
next three months, could you  
improve your business operations?**



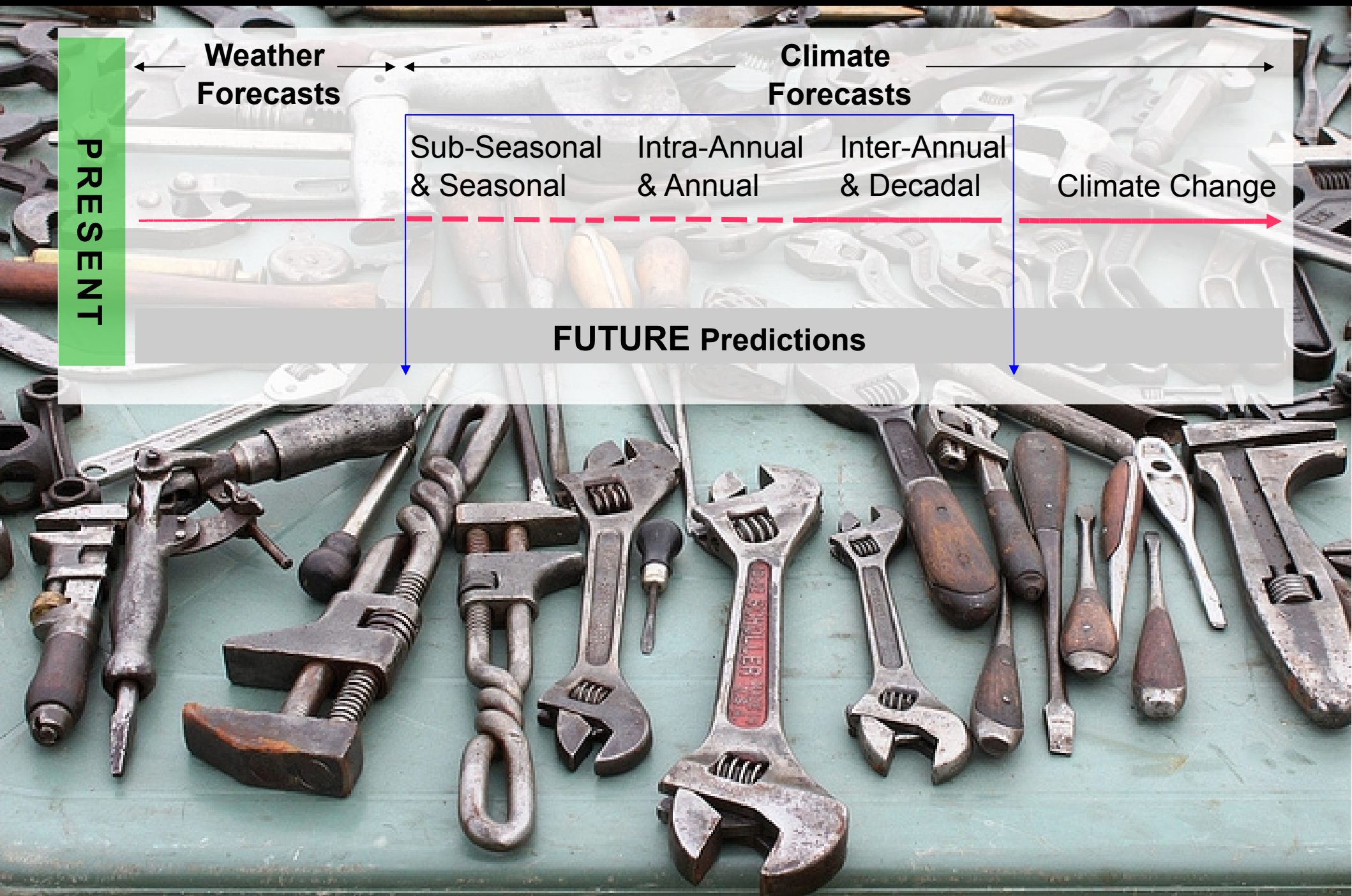


**Applications:** Climate risk management





# Climate Forecasting Unit



PRESENT

Weather  
Forecasts

Climate  
Forecasts

Sub-Seasonal  
& Seasonal

Intra-Annual  
& Annual

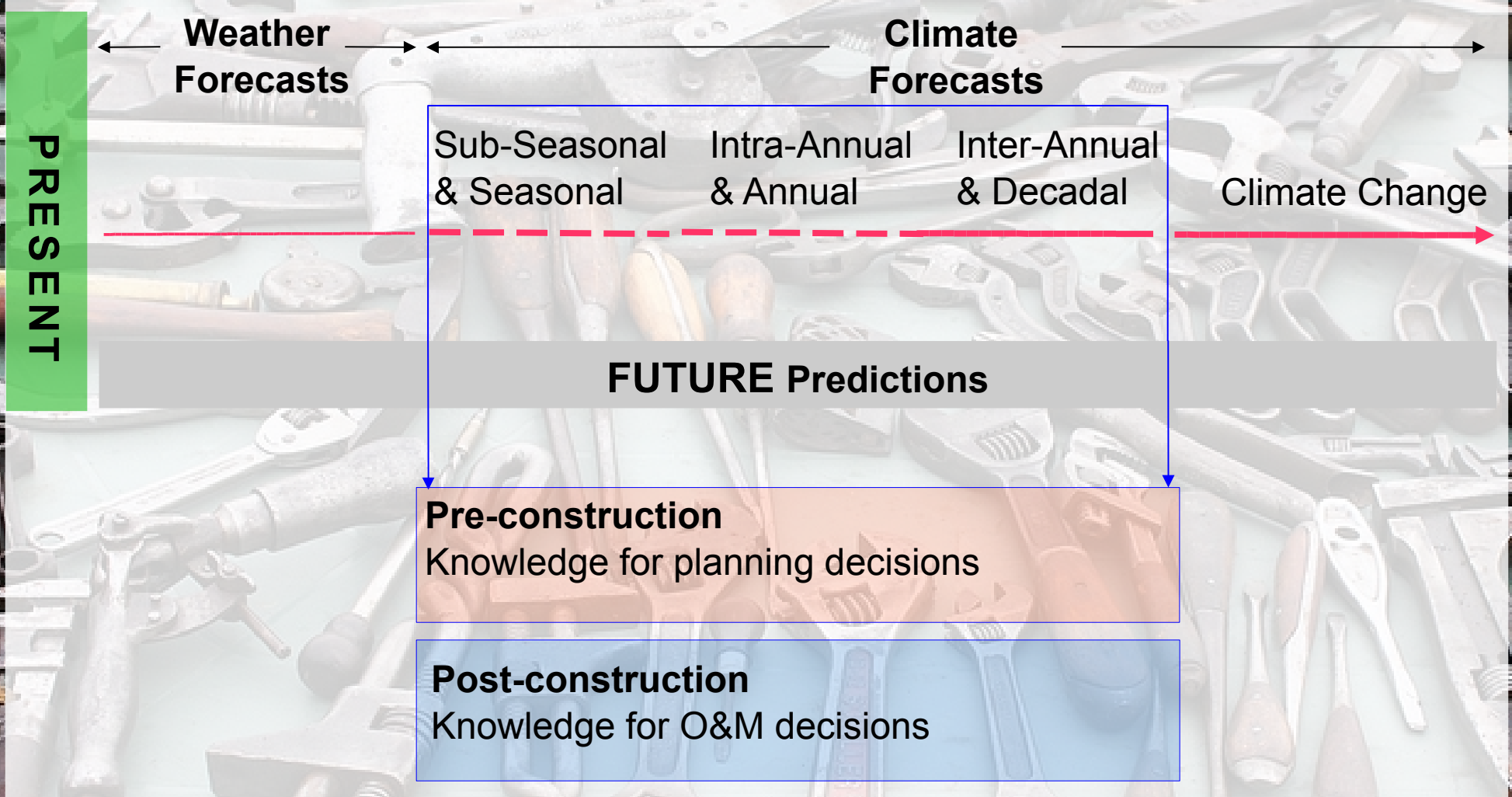
Inter-Annual  
& Decadal

Climate Change

FUTURE Predictions



# Climate Forecasting Unit



## How predictions are made: Global climate models

Long term forecast for

**Barcelona, Catalonia (Spain)**



















Overview

Hour by hour

Long term

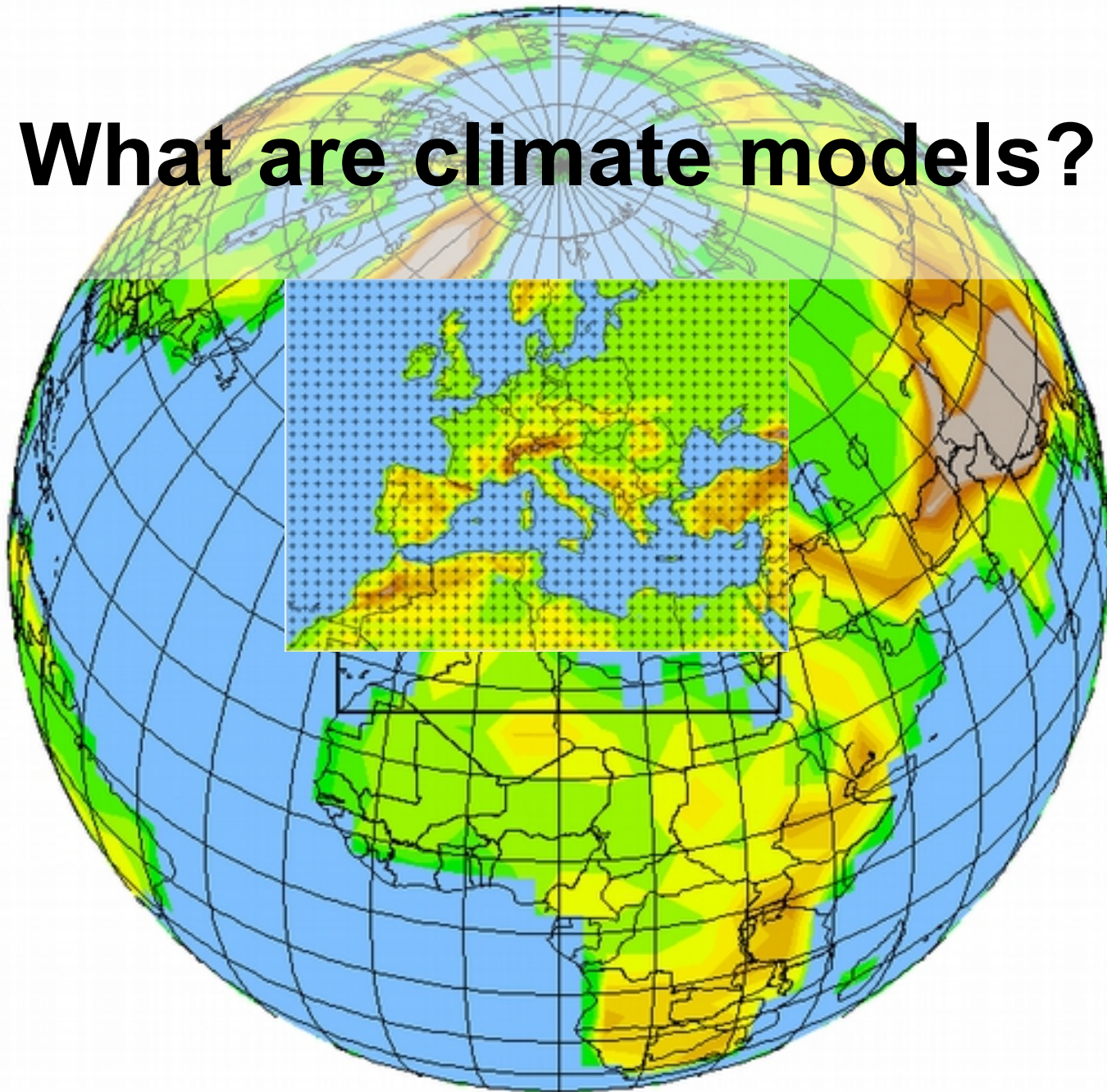
Statistics

### Long term forecast

Tuesday 11 March 13–19	Wednesday 12 March 13–19	Thursday 13 March 13–19	Friday 14 March 13–19	Saturday 15 March 13–19	Sunday 16 March 13–19	Monday 17 March 13–19	Tuesday 18 March 13–19	Wednesday 19 March 13–19
								
15°	14°	15°	15°	18°	16°	17°	16°	16°
0 mm	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm
								

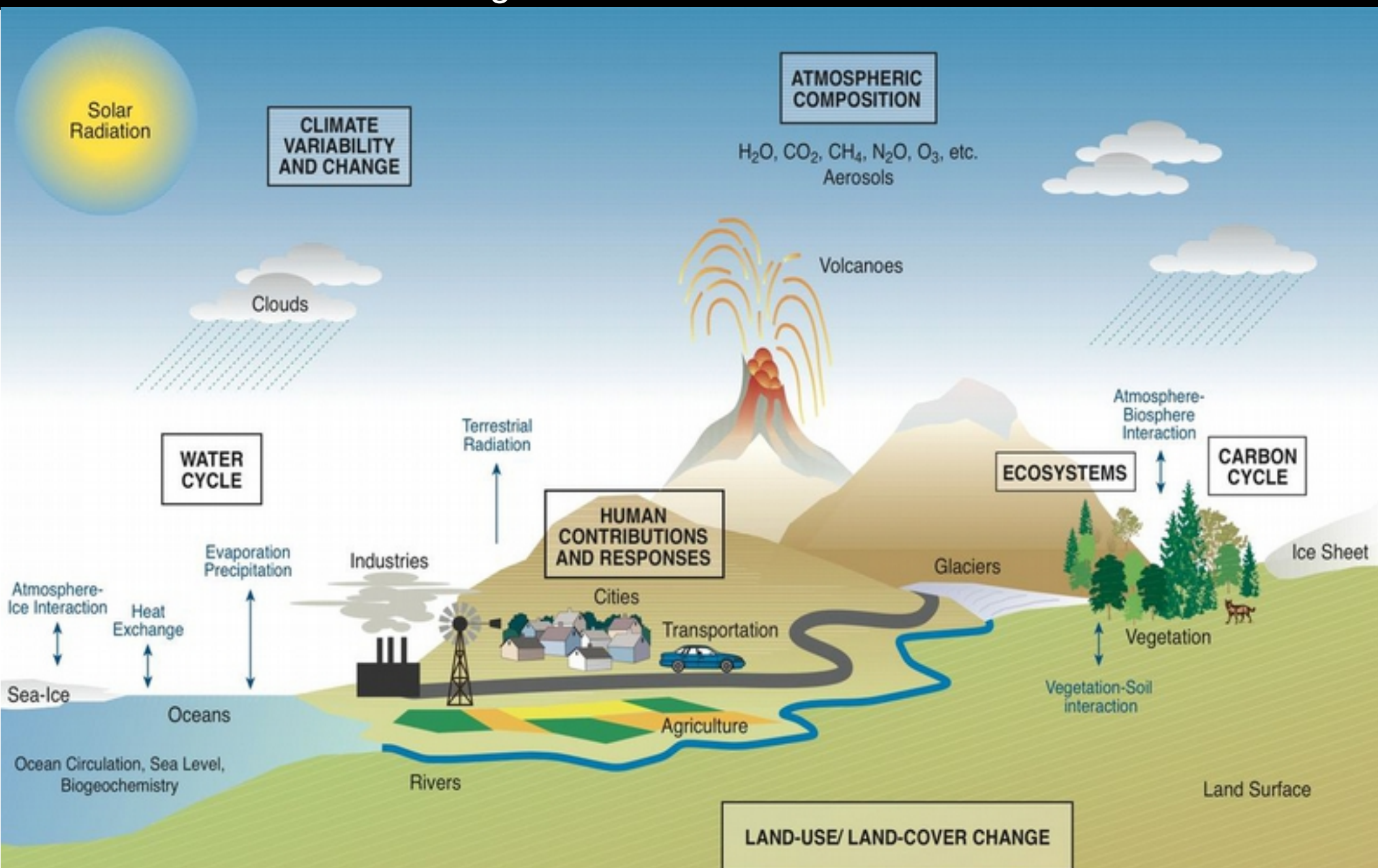


# What are climate models?





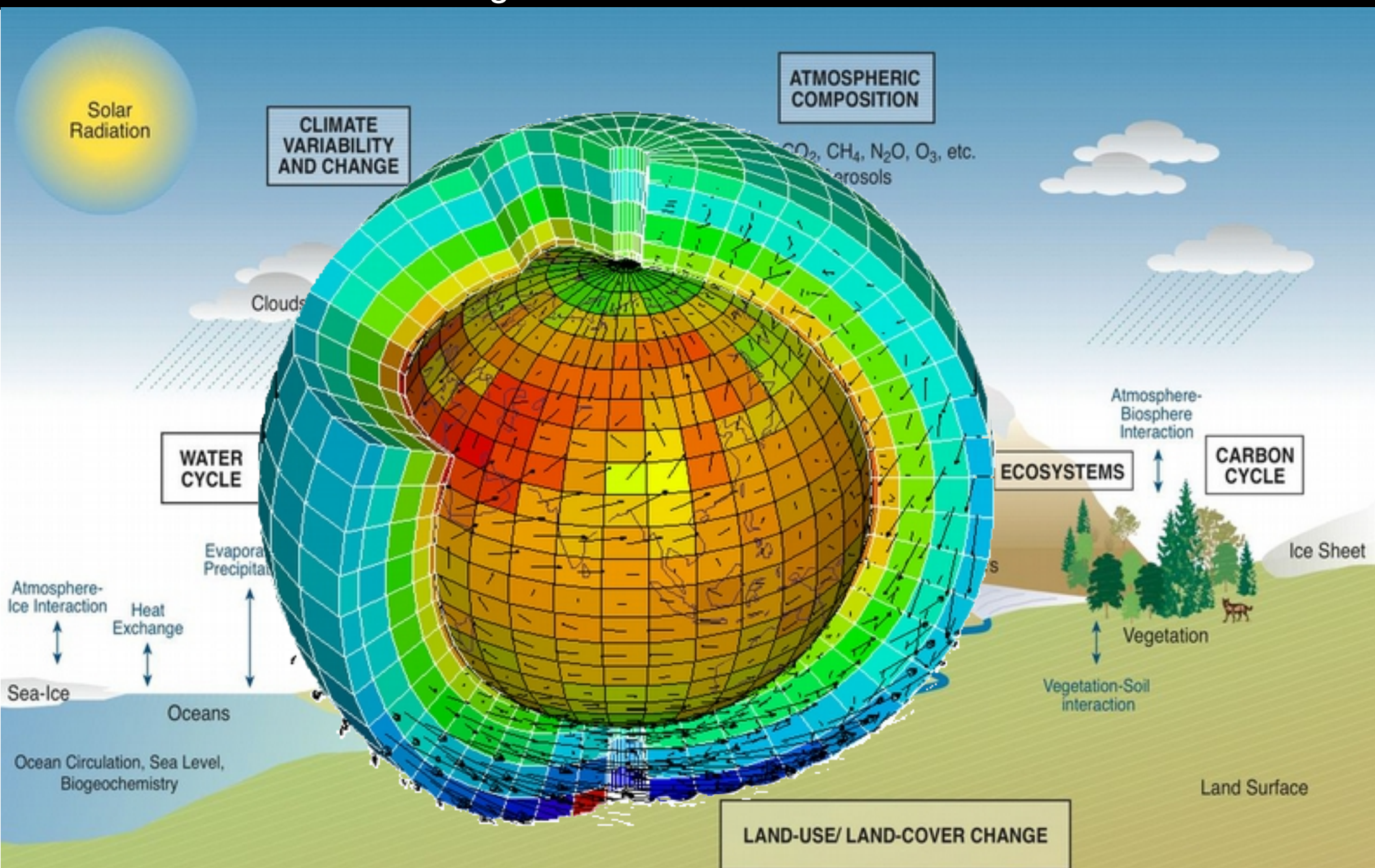
# Climate Forecasting Unit



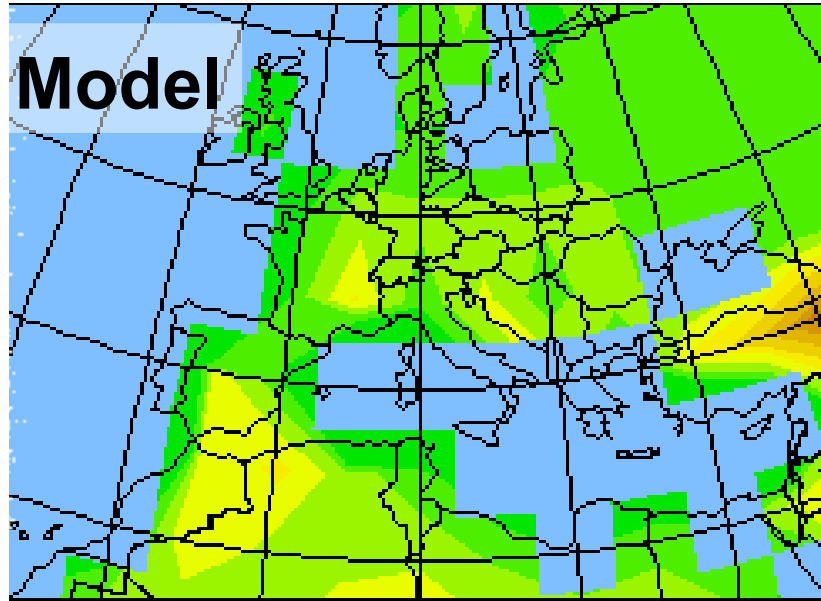




# Climate Forecasting Unit

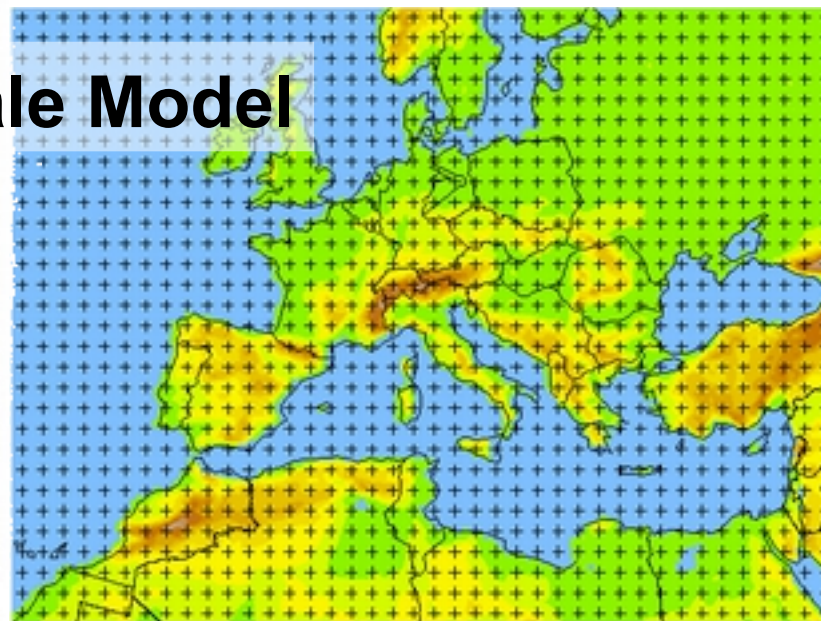


**Global Model**



> 100 km  
resolution

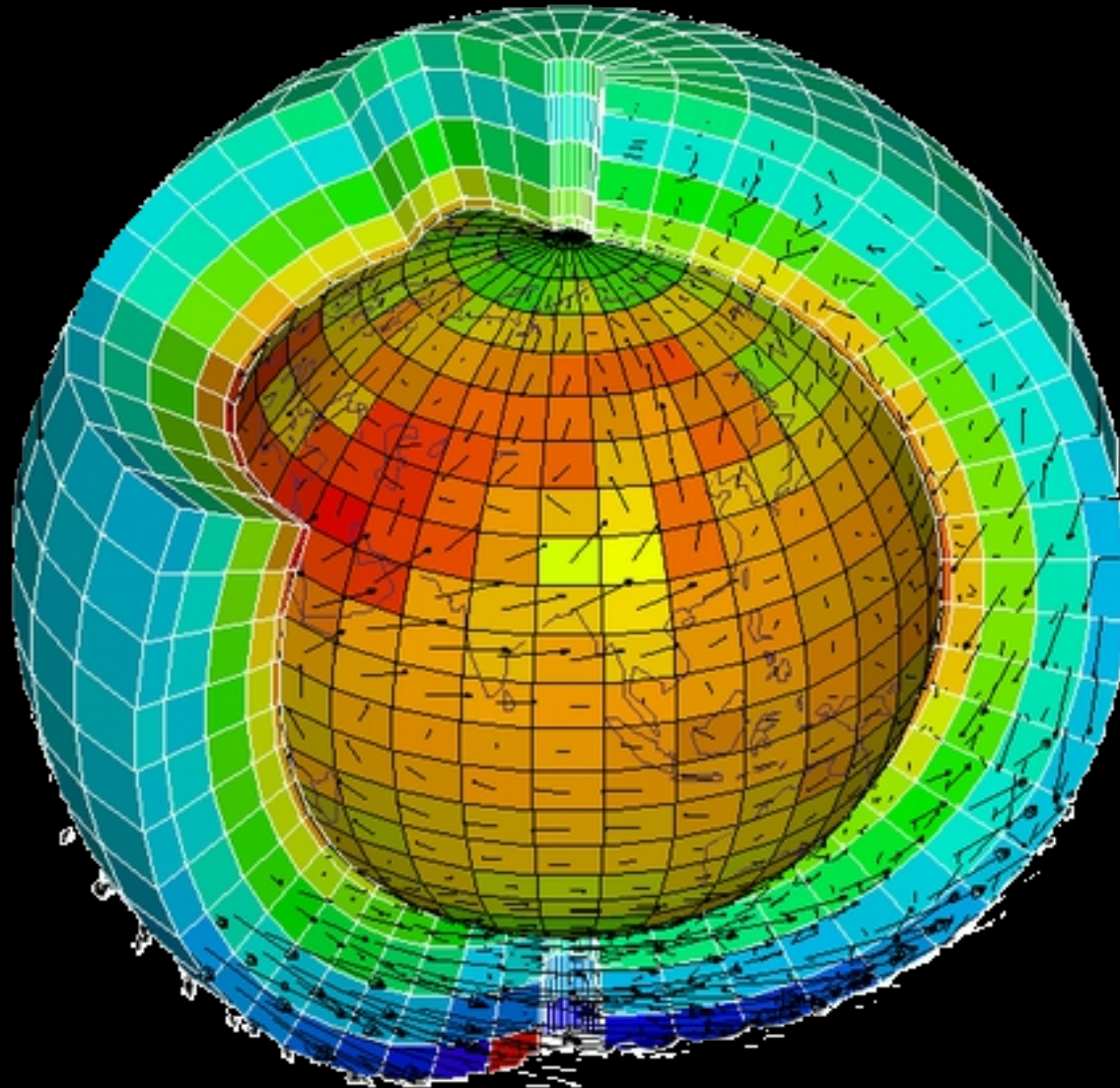
**Mesoscale Model**



< 100 km  
resolution



## Seasonal forecasts: What is possible







**I can tell you that there is a  
64% likelihood for wind speeds to be  
above normal for the coming season in  
North-East Brazil region.**



## North-East Brazil Example

### Seasonal Average Wind Speeds

**Summer 2013/4 Forecast:** December-February (inclusive)

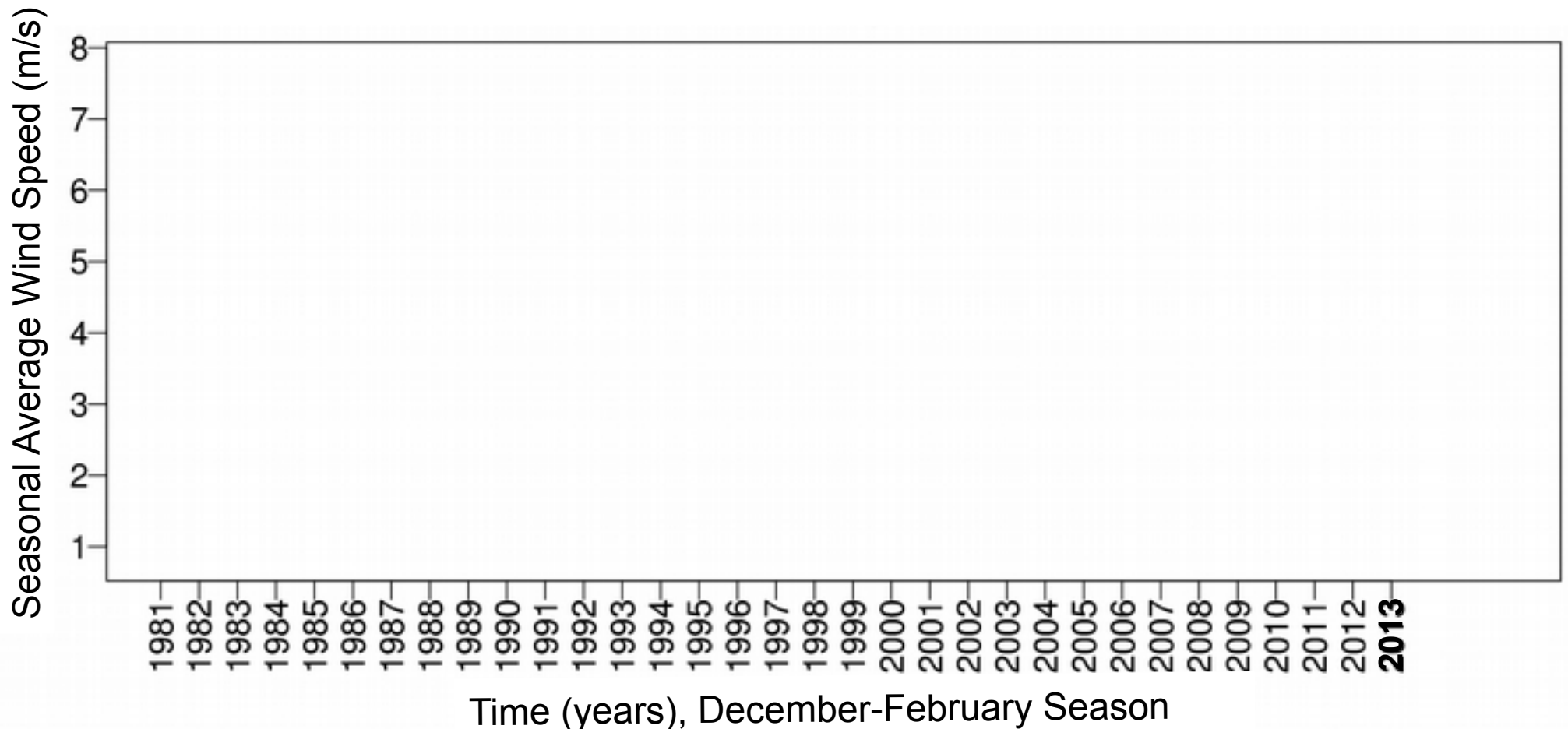




## North-East Brazil Example Seasonal Average Wind Speeds

**Summer 2013/4 Forecast:** December-February (inclusive)

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10m wind speed observations: ERA-Interim  
1 month forecast lead time: Started 1<sup>st</sup> Nov  
Simple bias correction



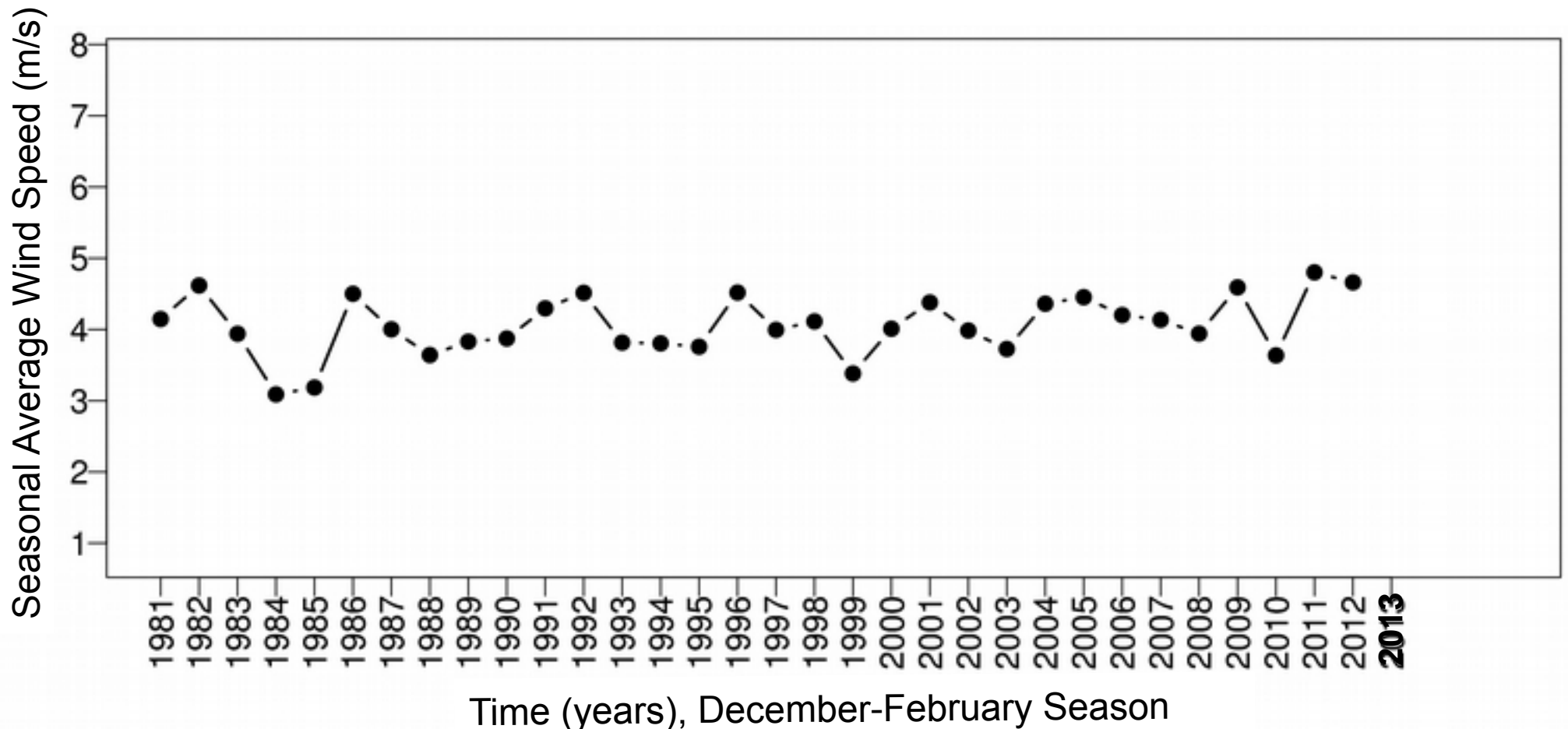




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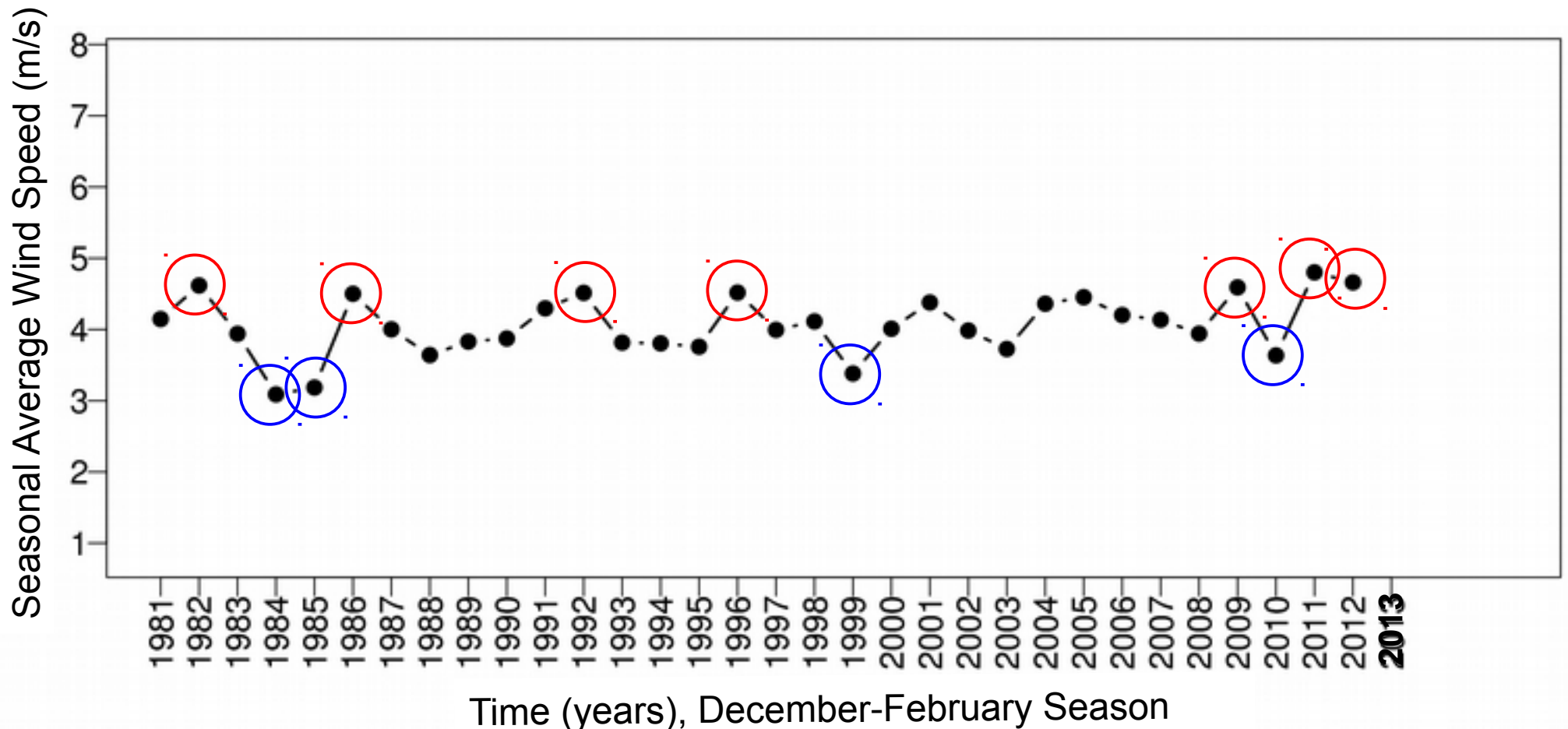
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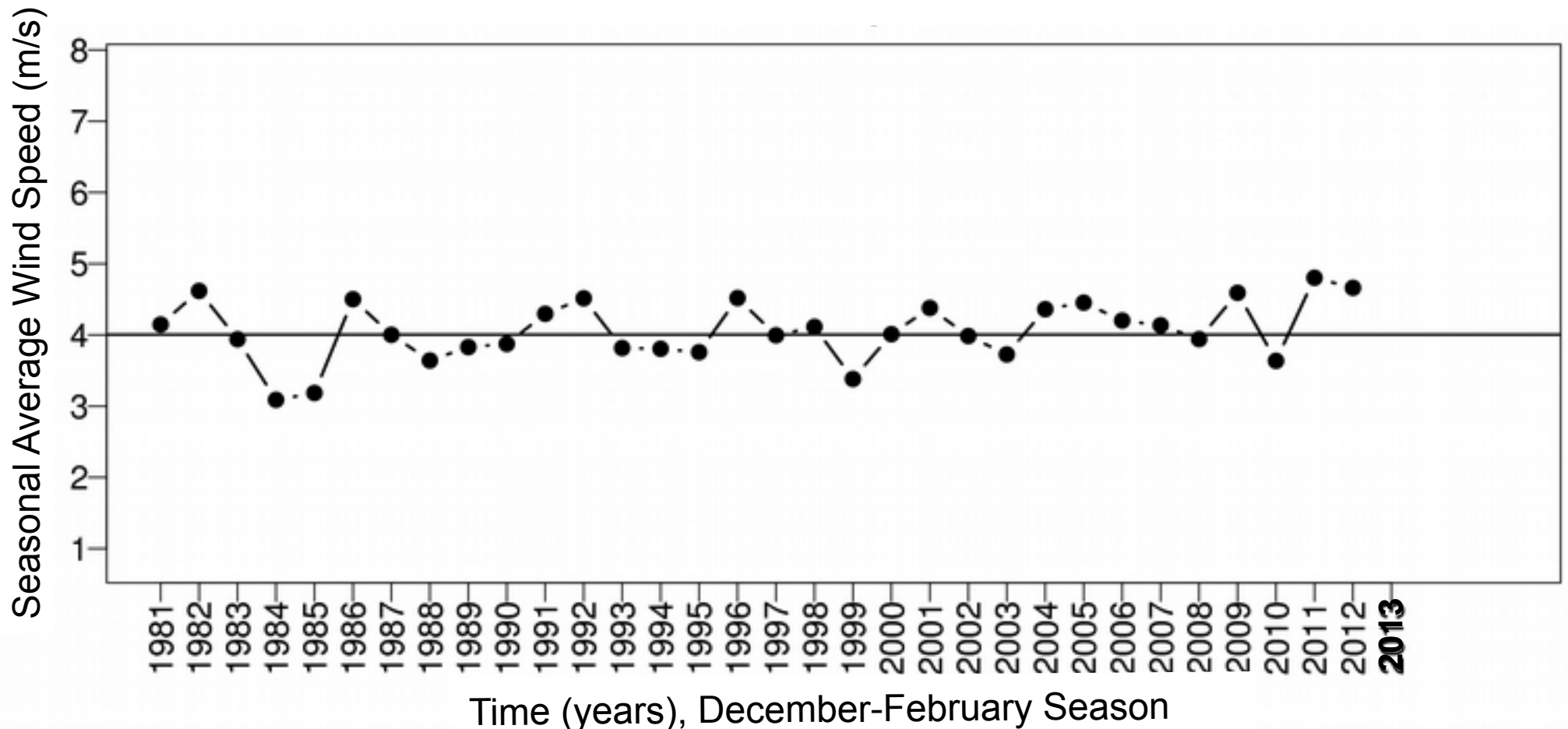




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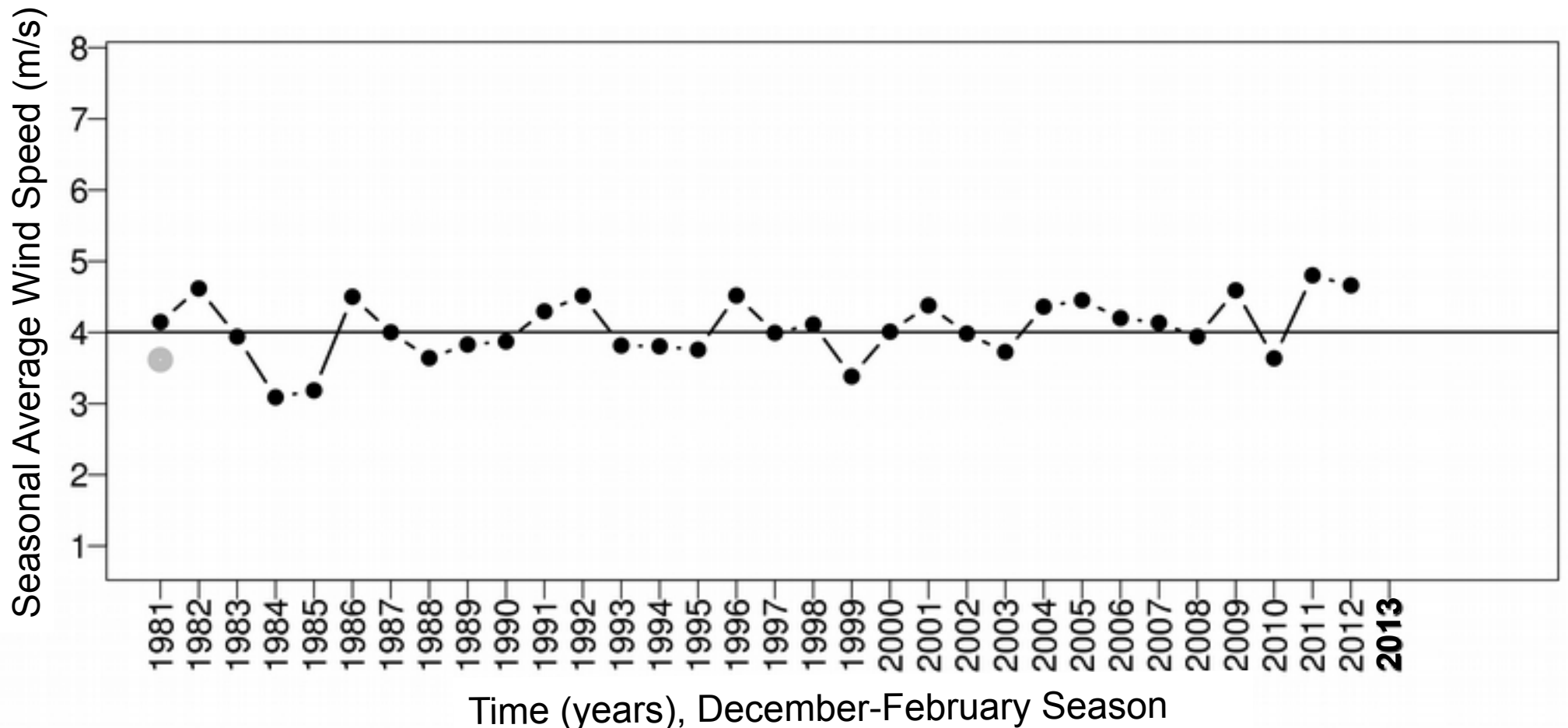




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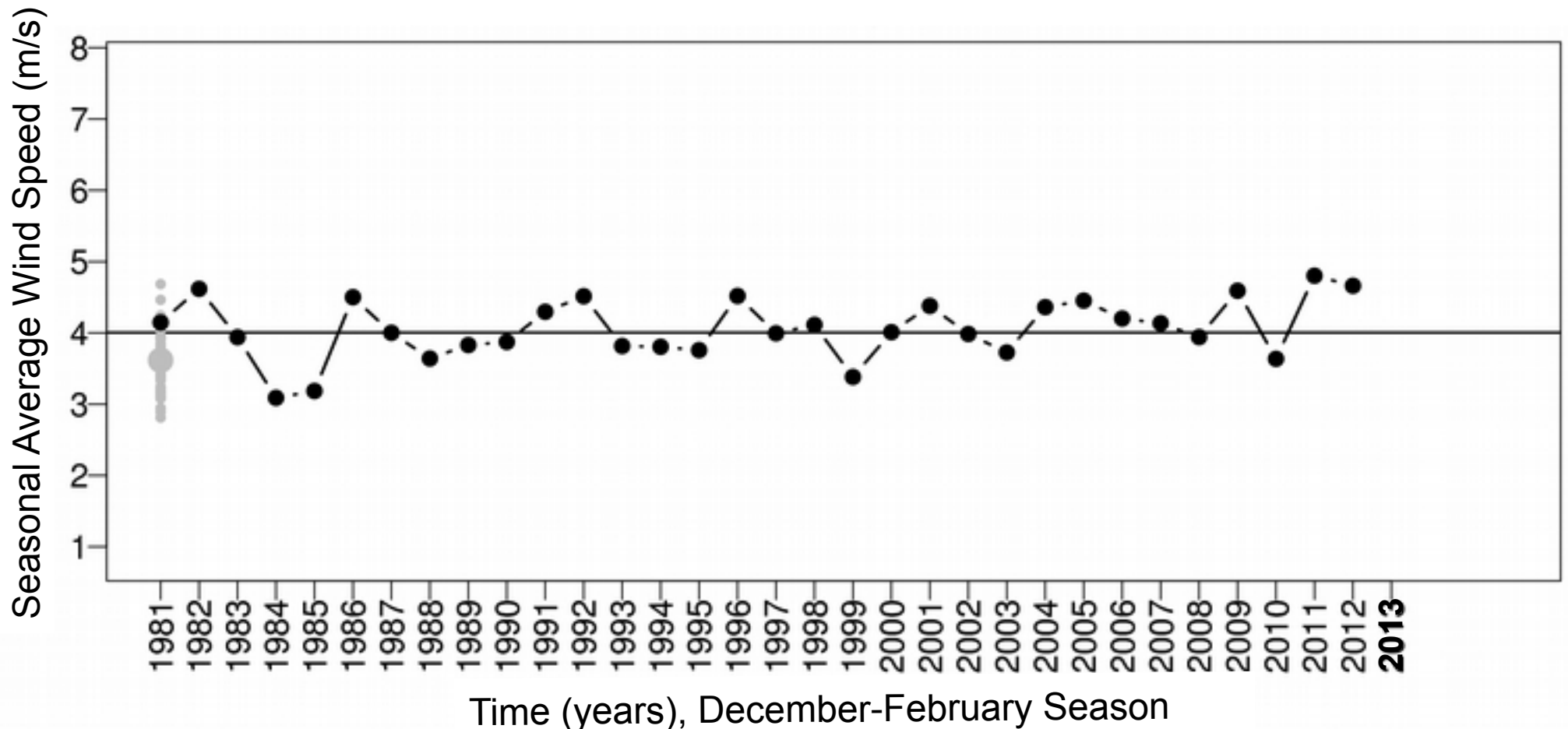




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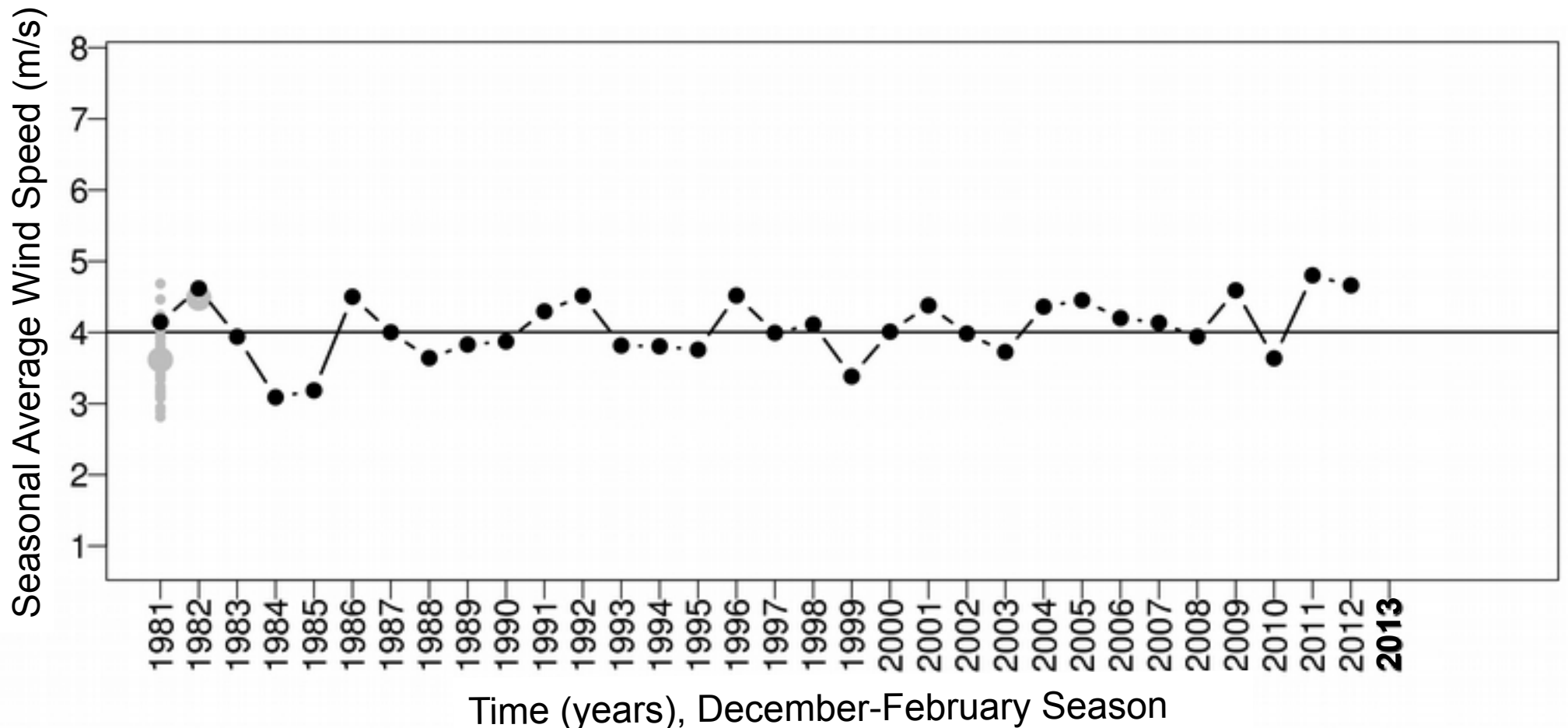




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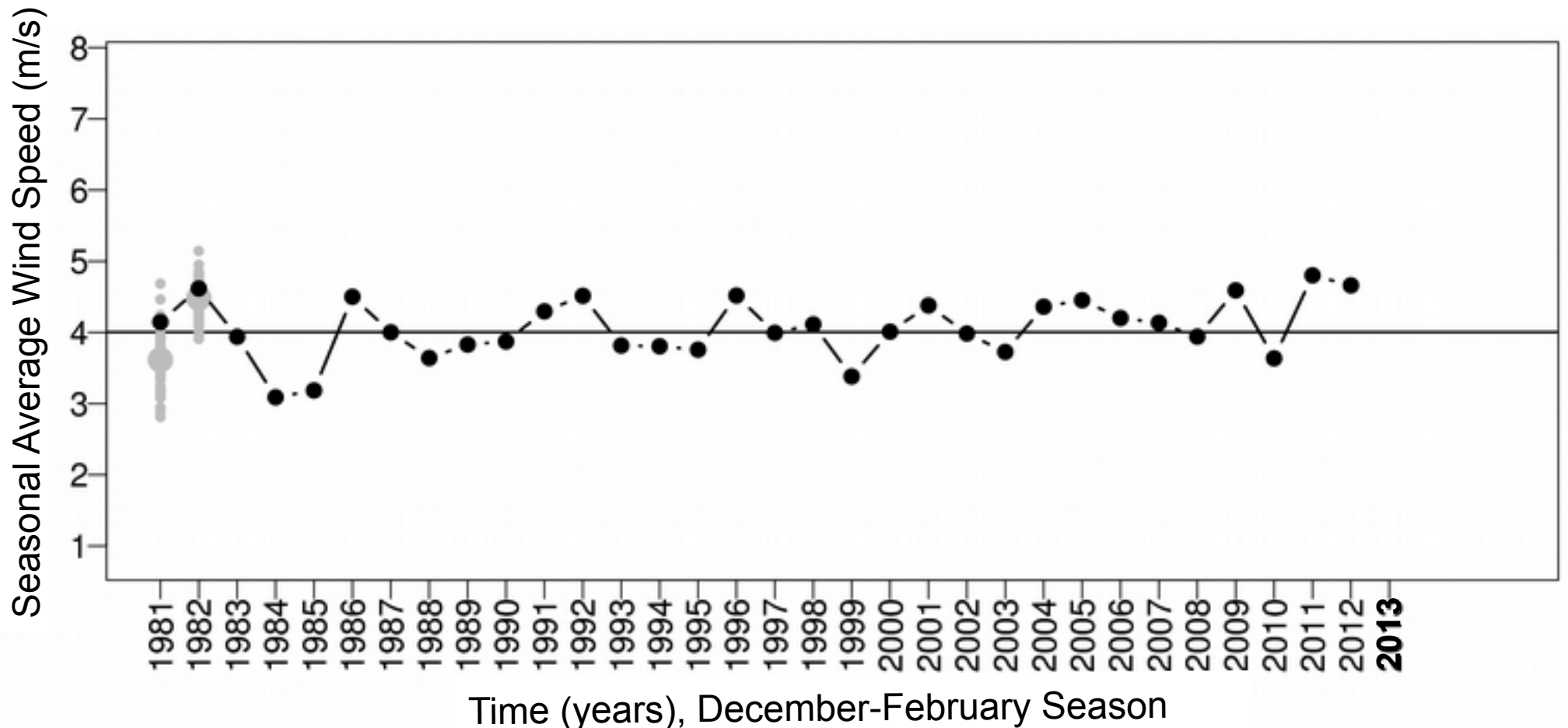




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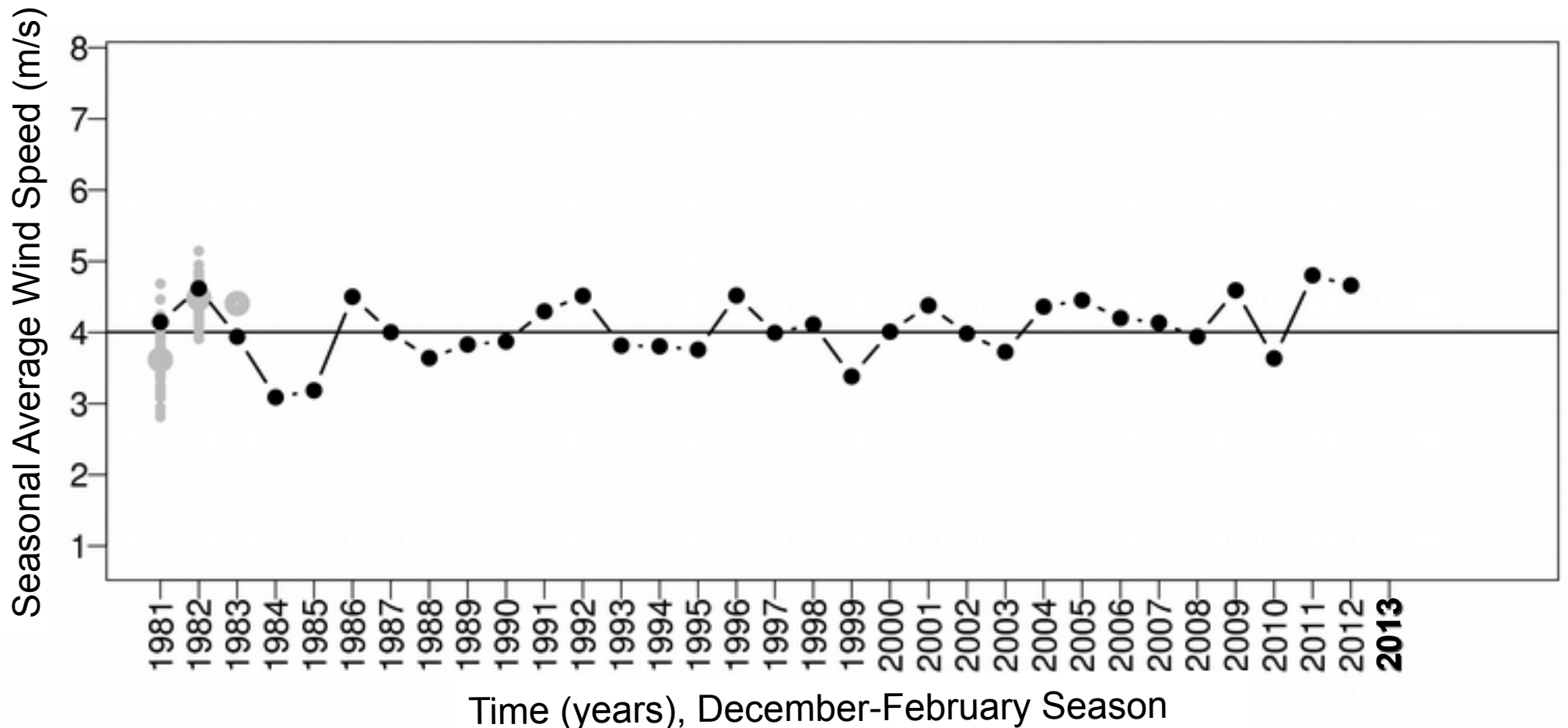




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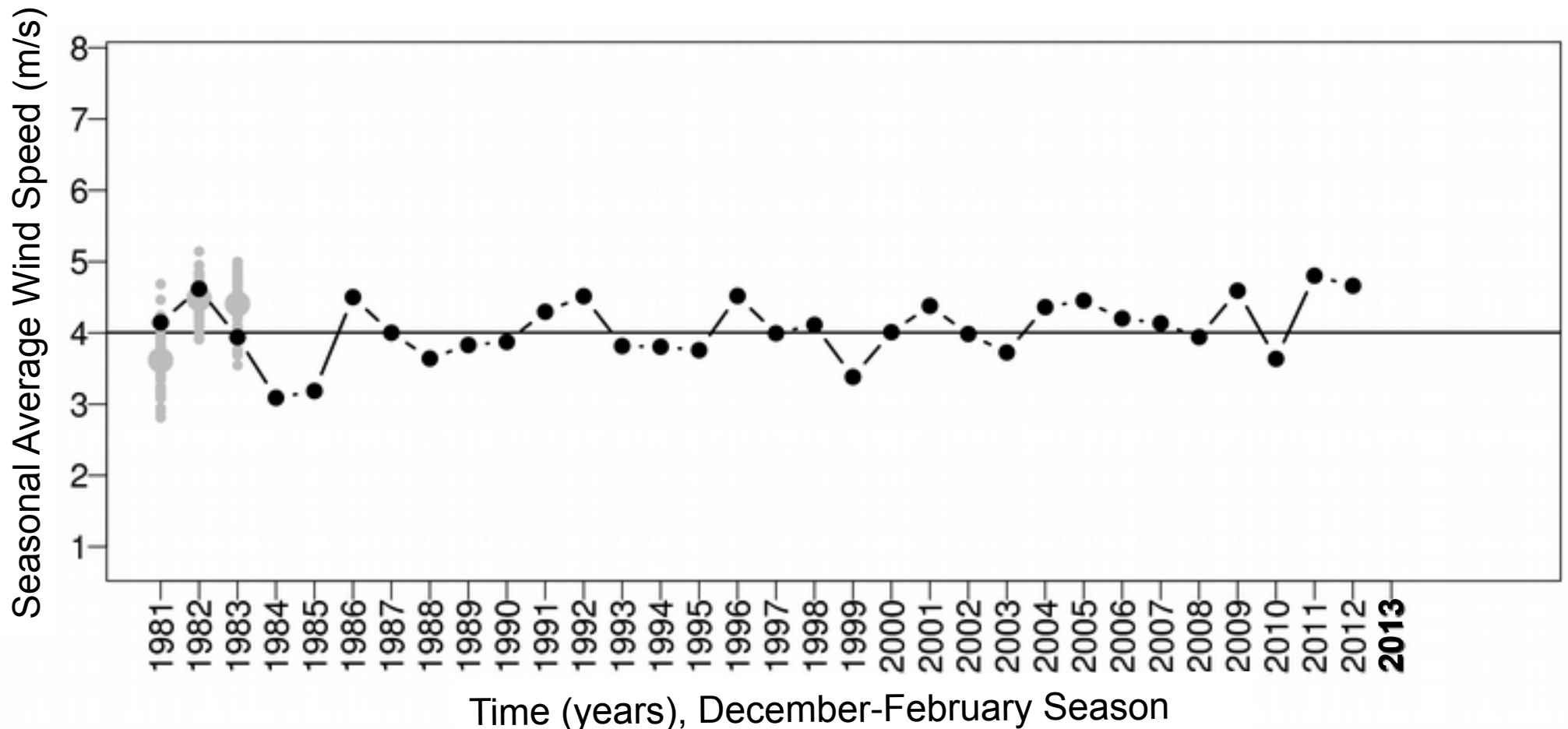




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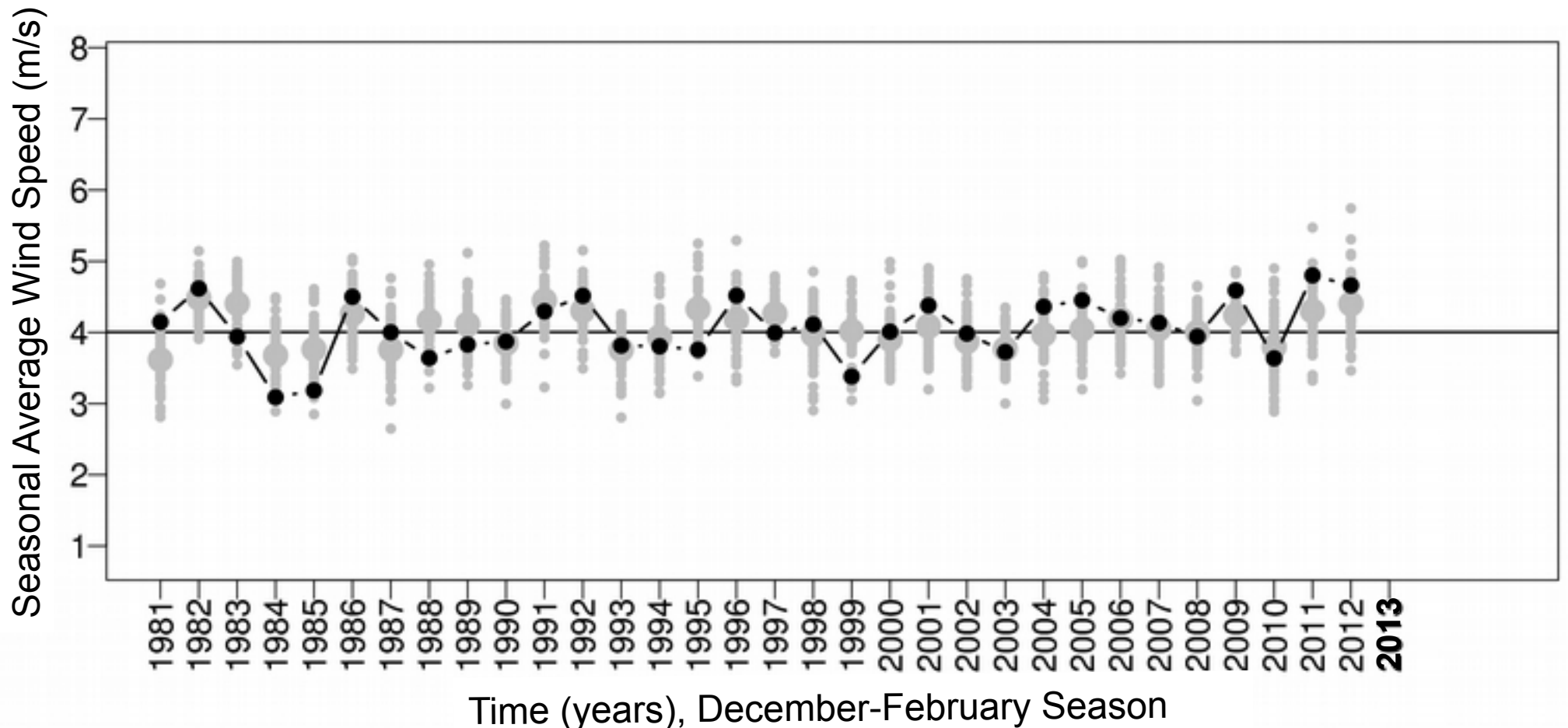




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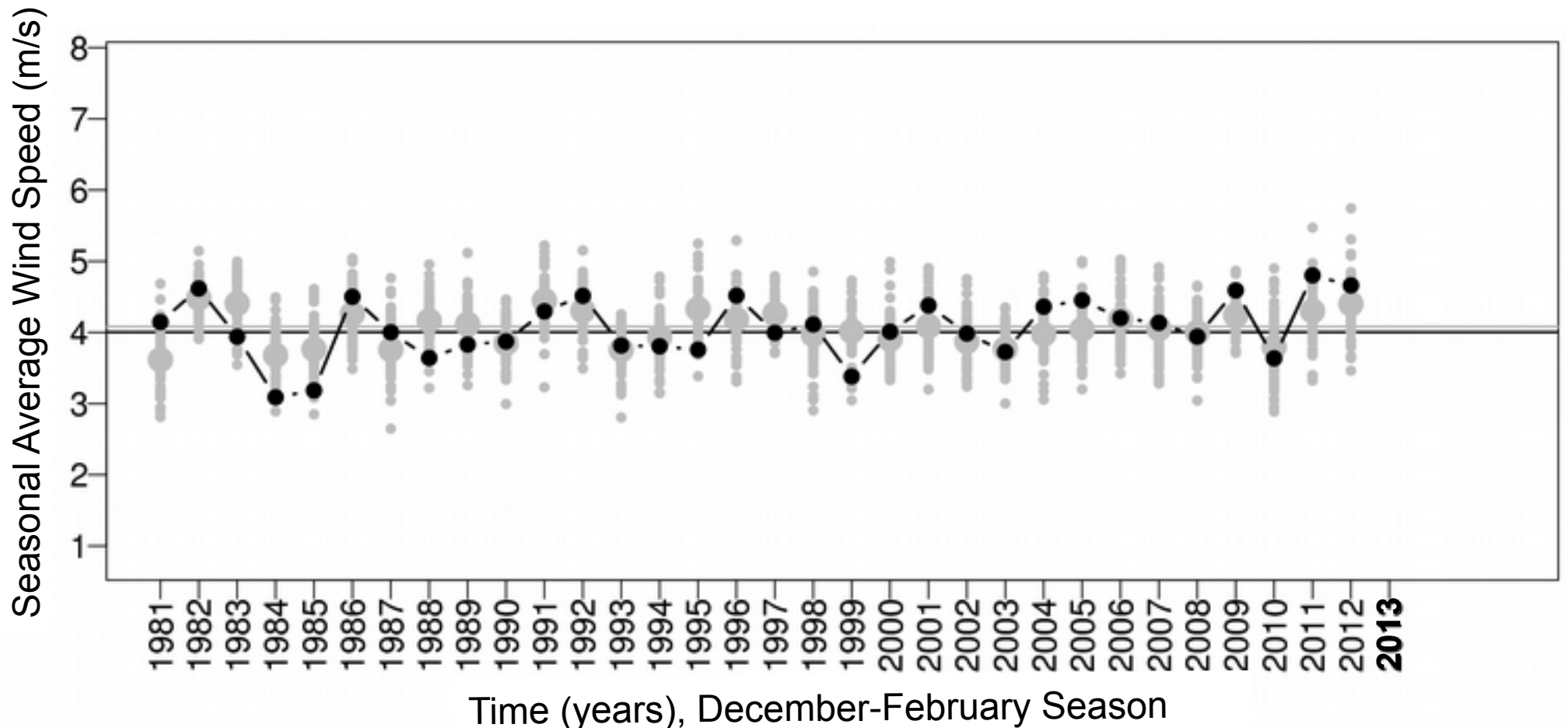




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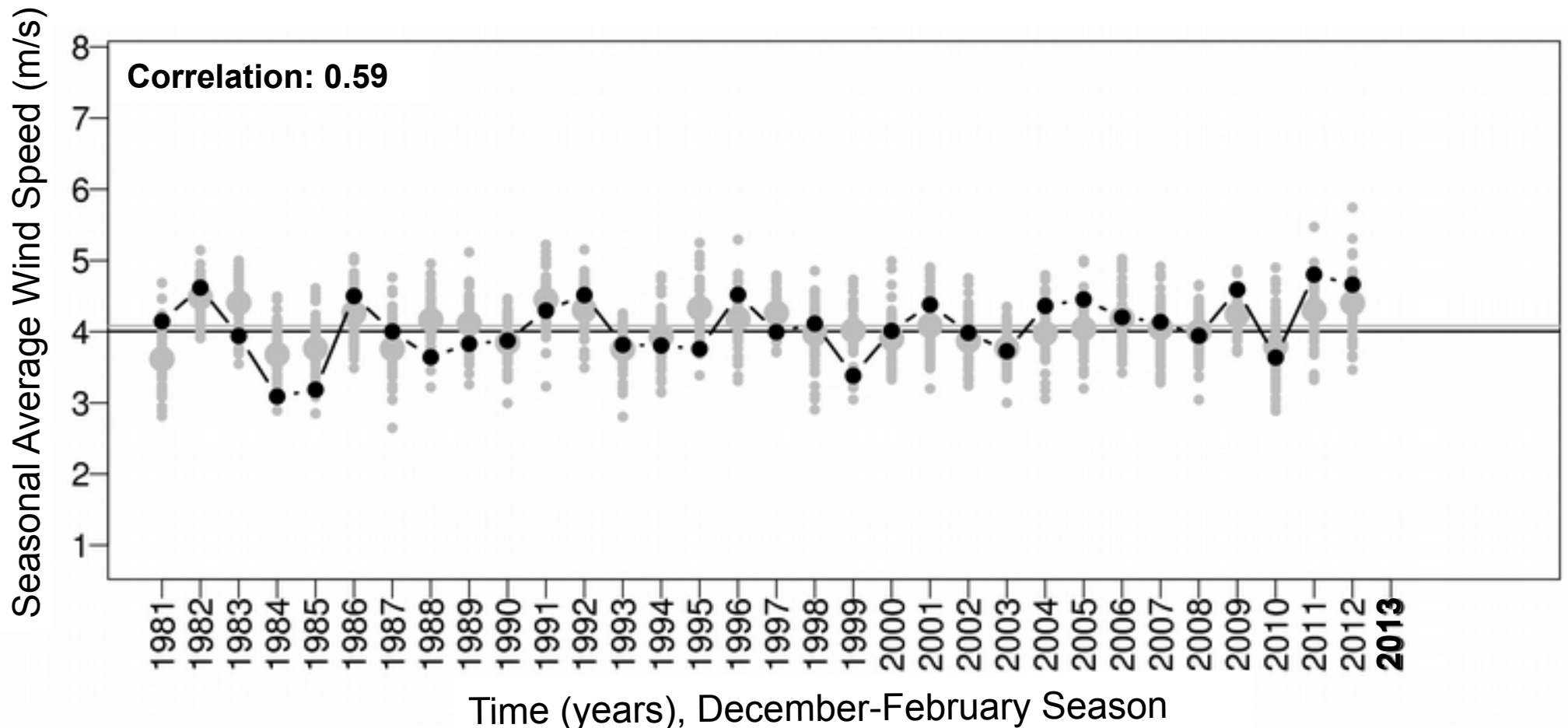




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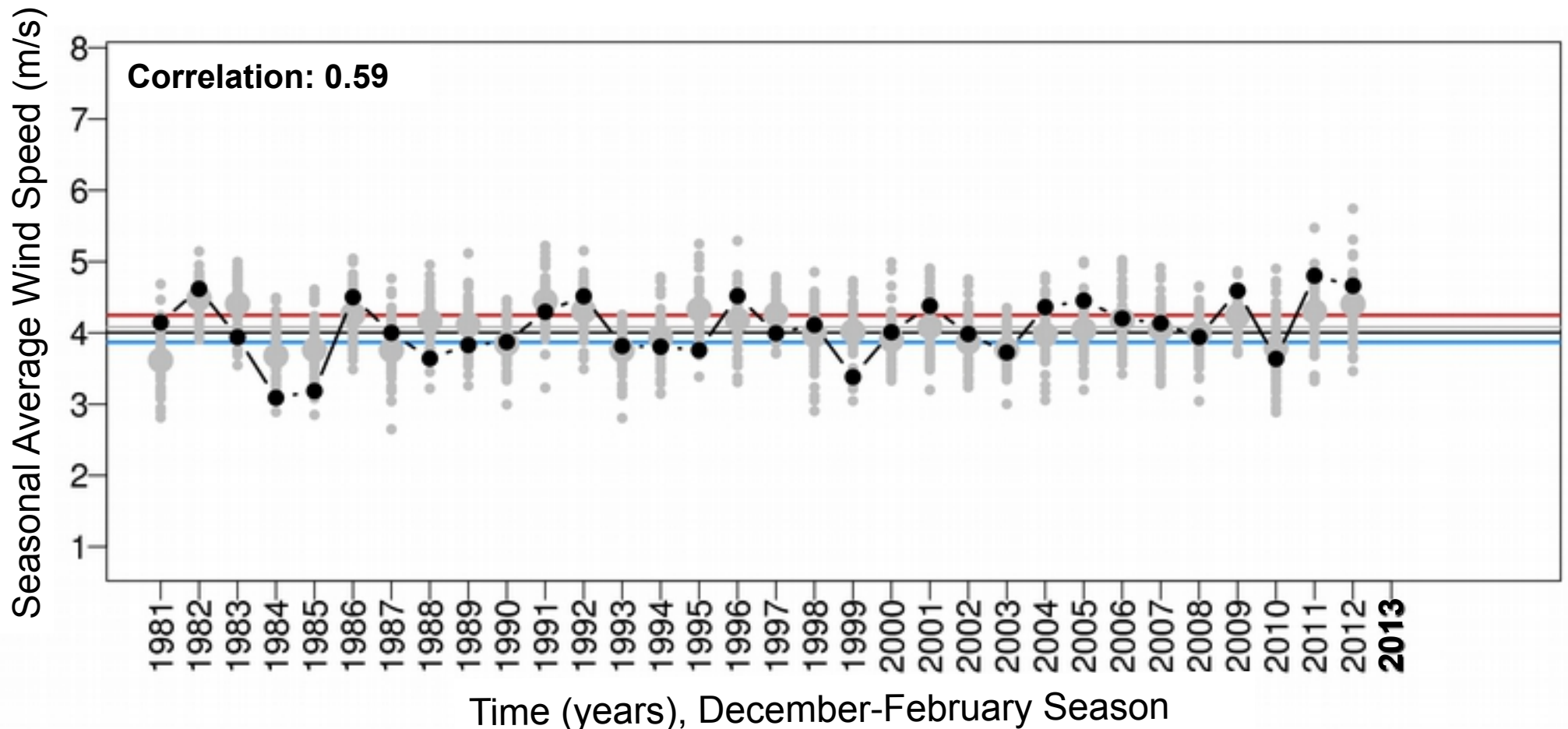




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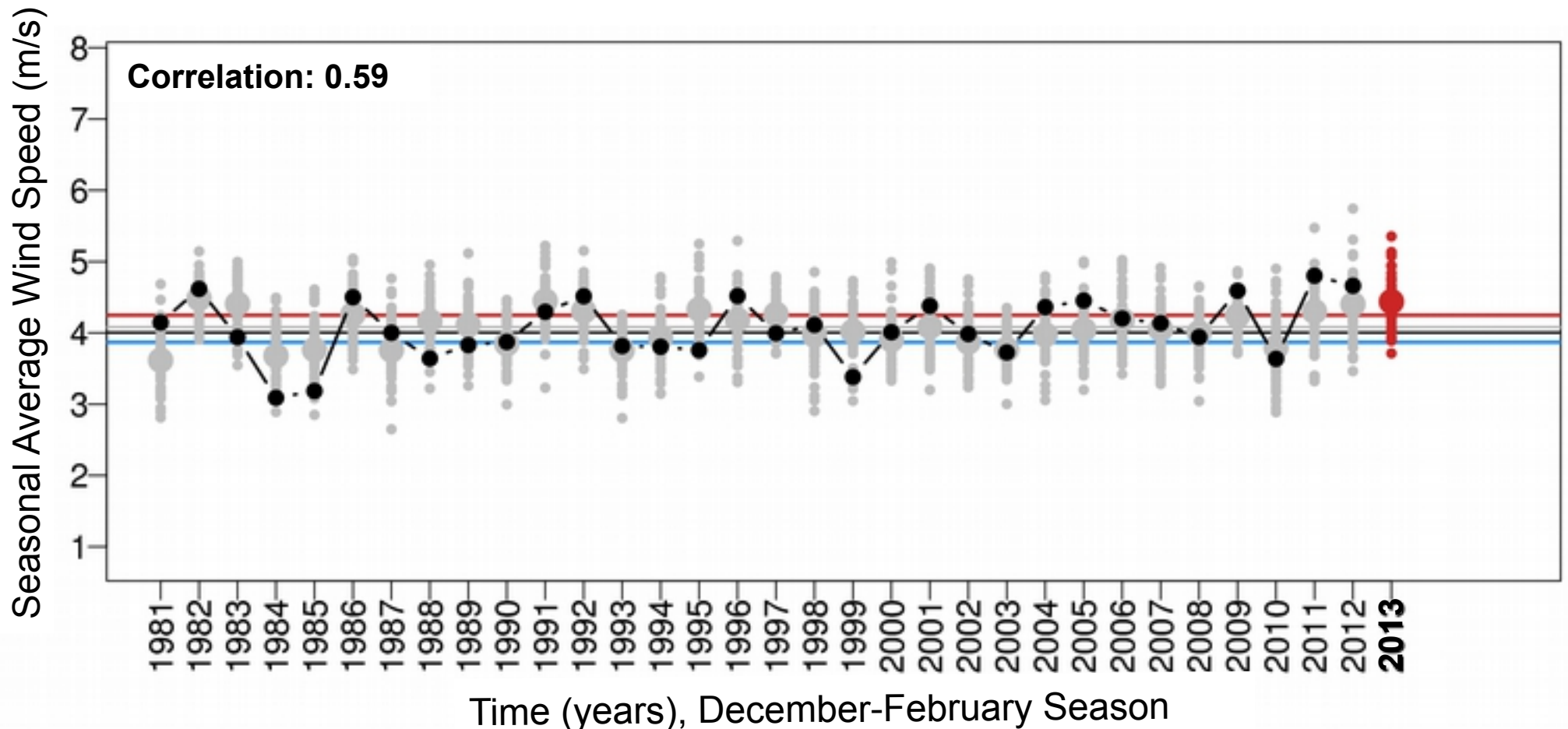




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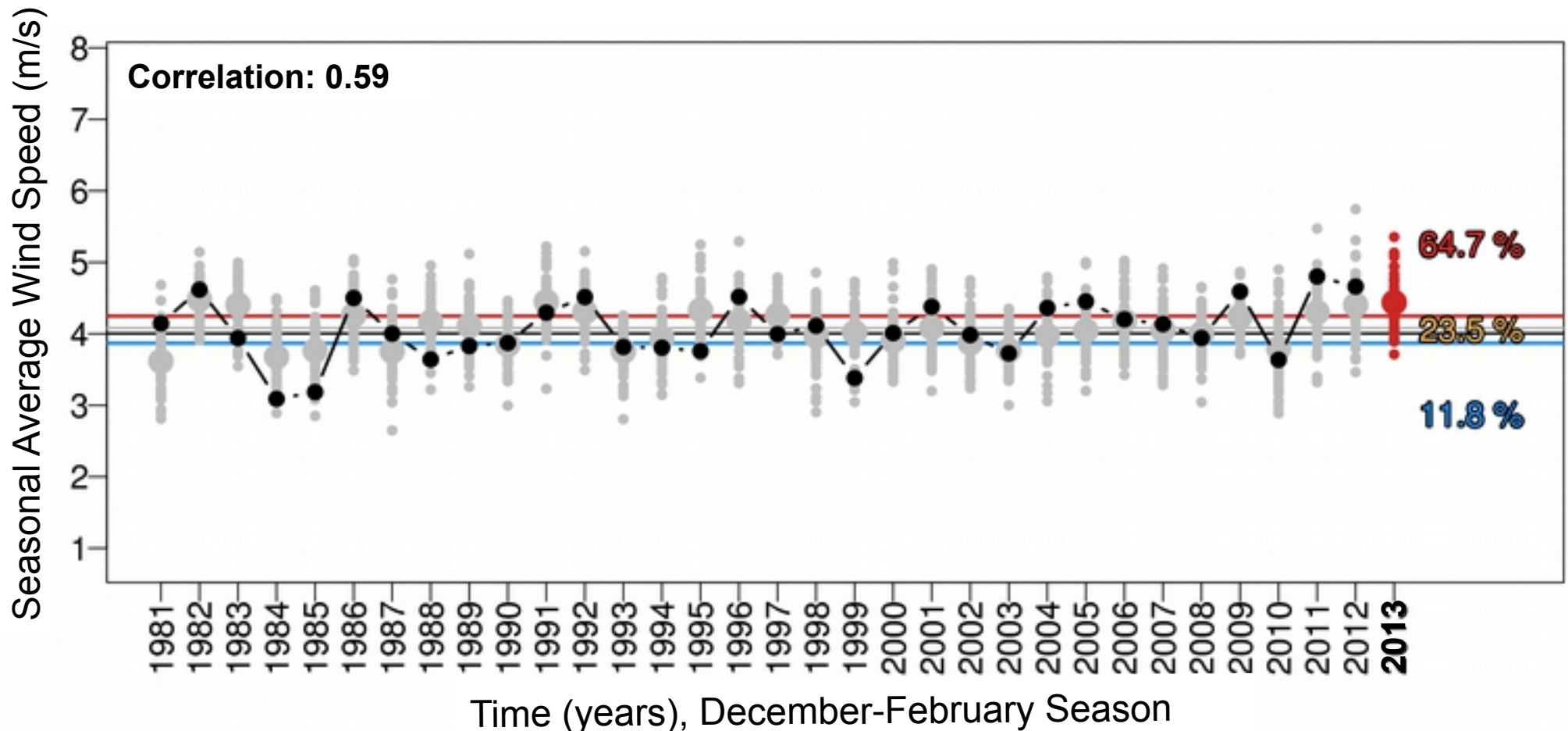




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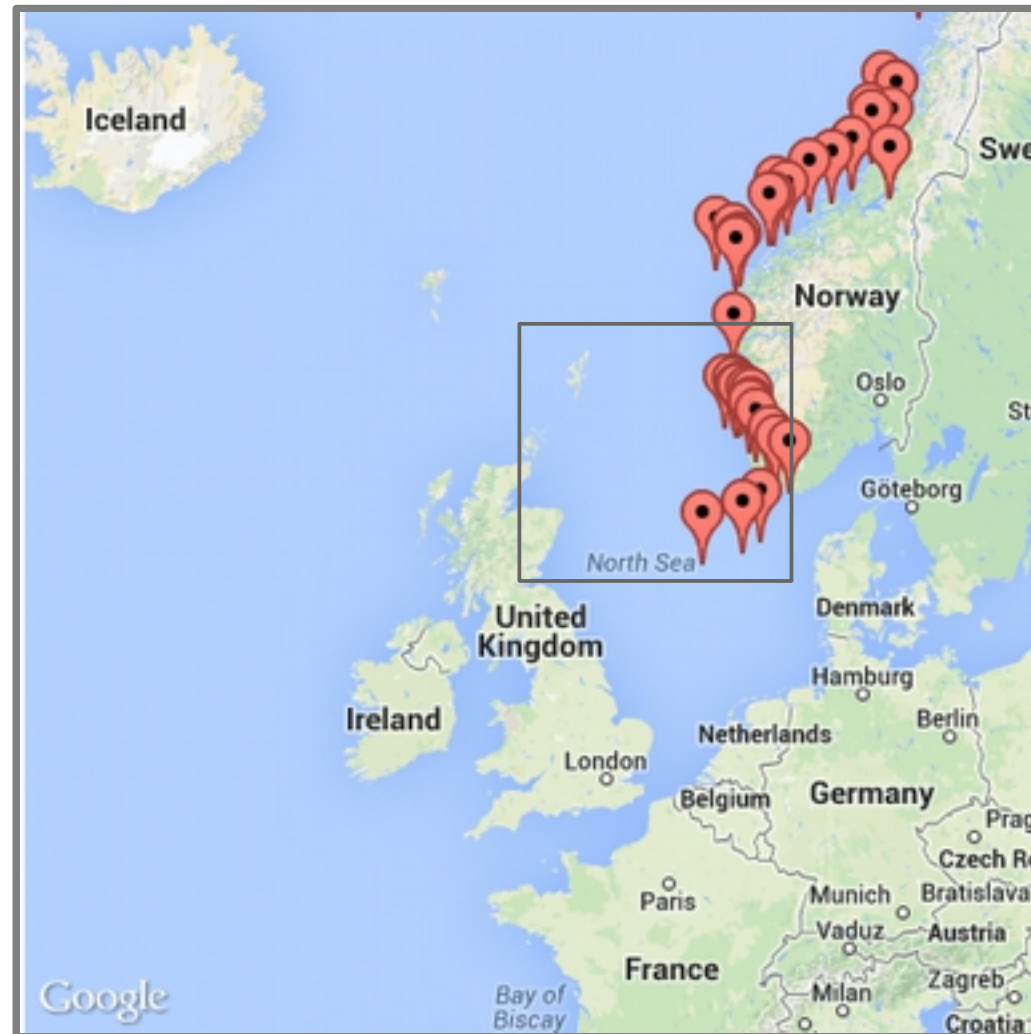




## North-Sea Example

### Seasonal Average Wind Speeds

**Winter 2013/4 Forecast:** December-February (inclusive)

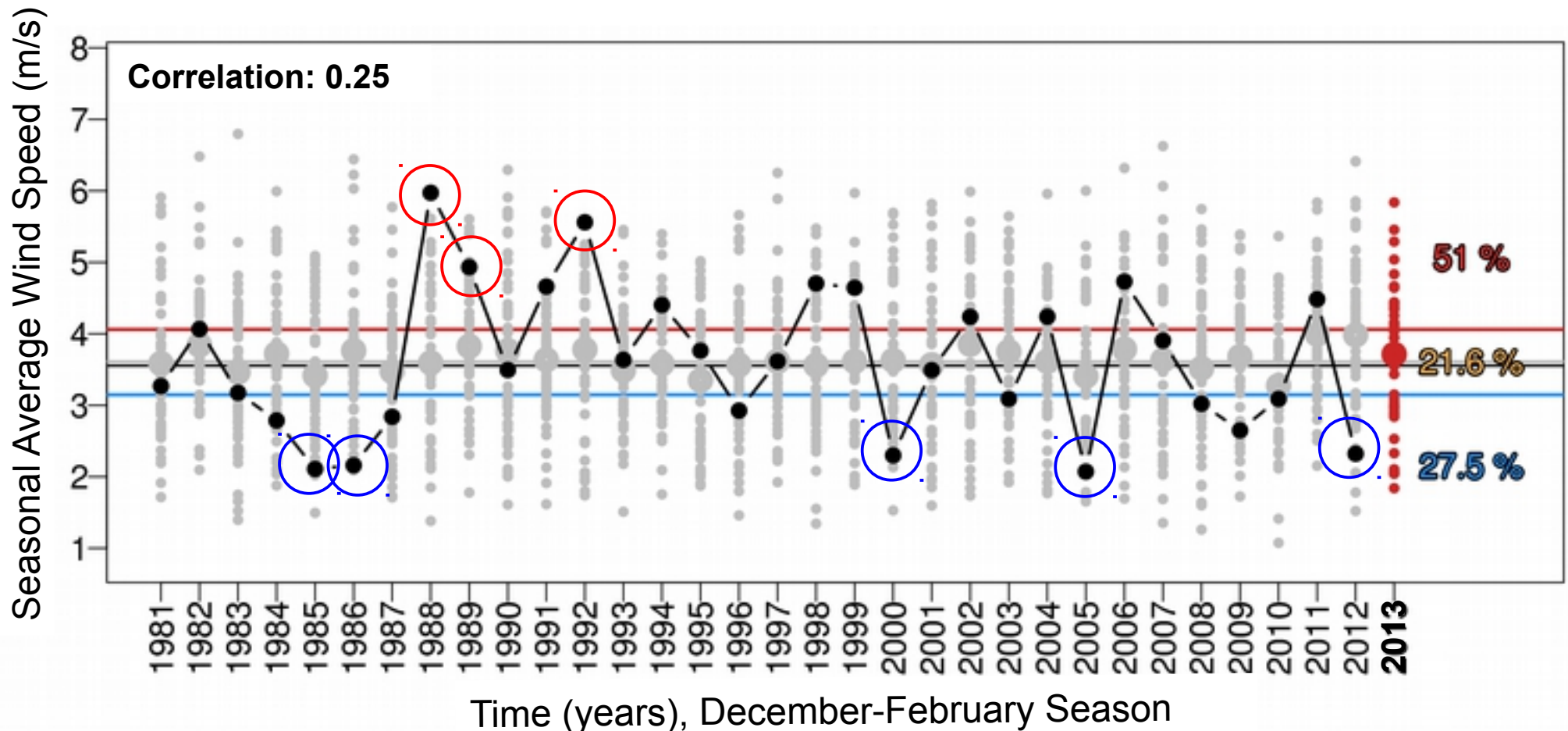




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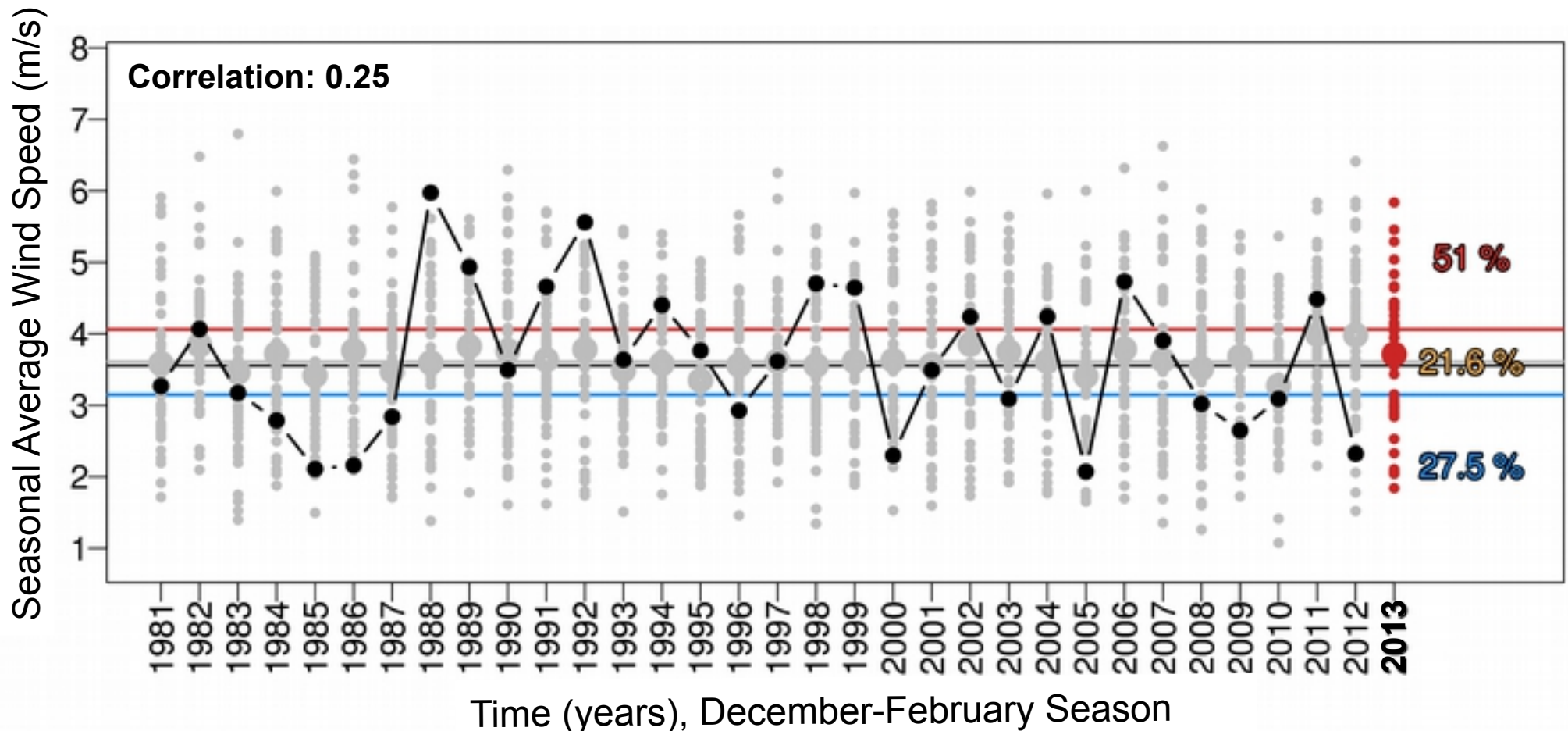




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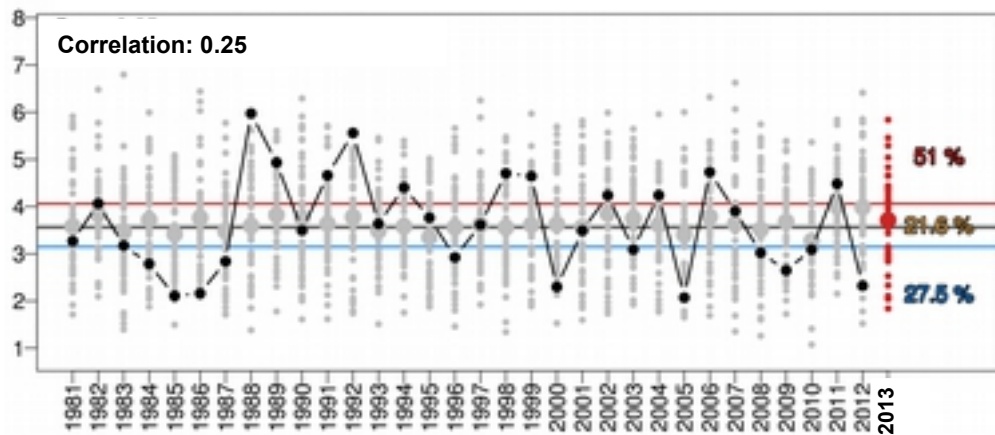


## Seasonal Average Wind Speeds Dec-Feb (inclusive) 2013/4 Forecast

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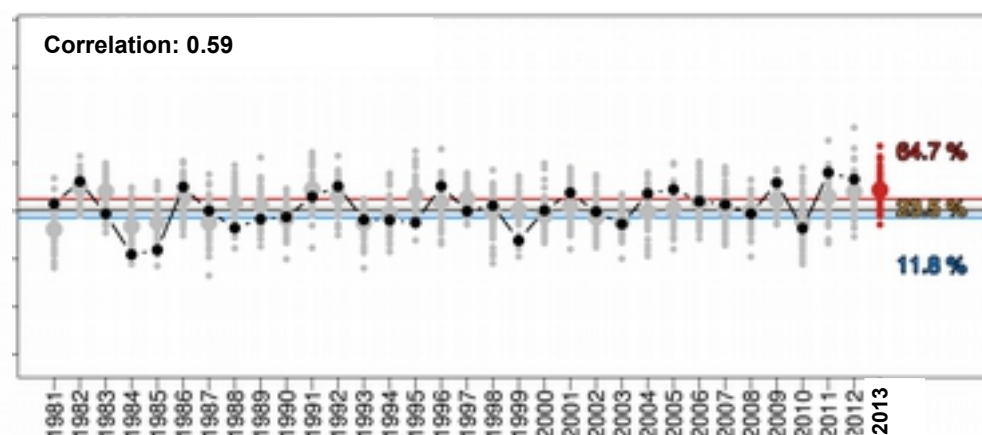
### North-Sea Region:

Seasonal Average Wind Speed (m/s)



Time (yrs), December-February Season

### North-East Brazil Region:



Time (yrs), December-February Season



**If I could tell you the  
average wind conditions for the  
next three months, could you  
improve your business operations?**





How can a forecast benefit your decision making processes?



## How can a forecast benefit your decision making processes?

Ability to make decisions earlier.

Avoid subjective decision making.

Take calculated precautionary action.

Potential cost saving.



The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under the following projects:



CLIM-RUN, [www.climrun.eu](http://www.climrun.eu) (GA n° 265192)

EUPORIAS, [www.euporias.eu](http://www.euporias.eu) (GA n° 308291)

SPECS, [www.specs-fp7.eu](http://www.specs-fp7.eu) (GA n° 308378)

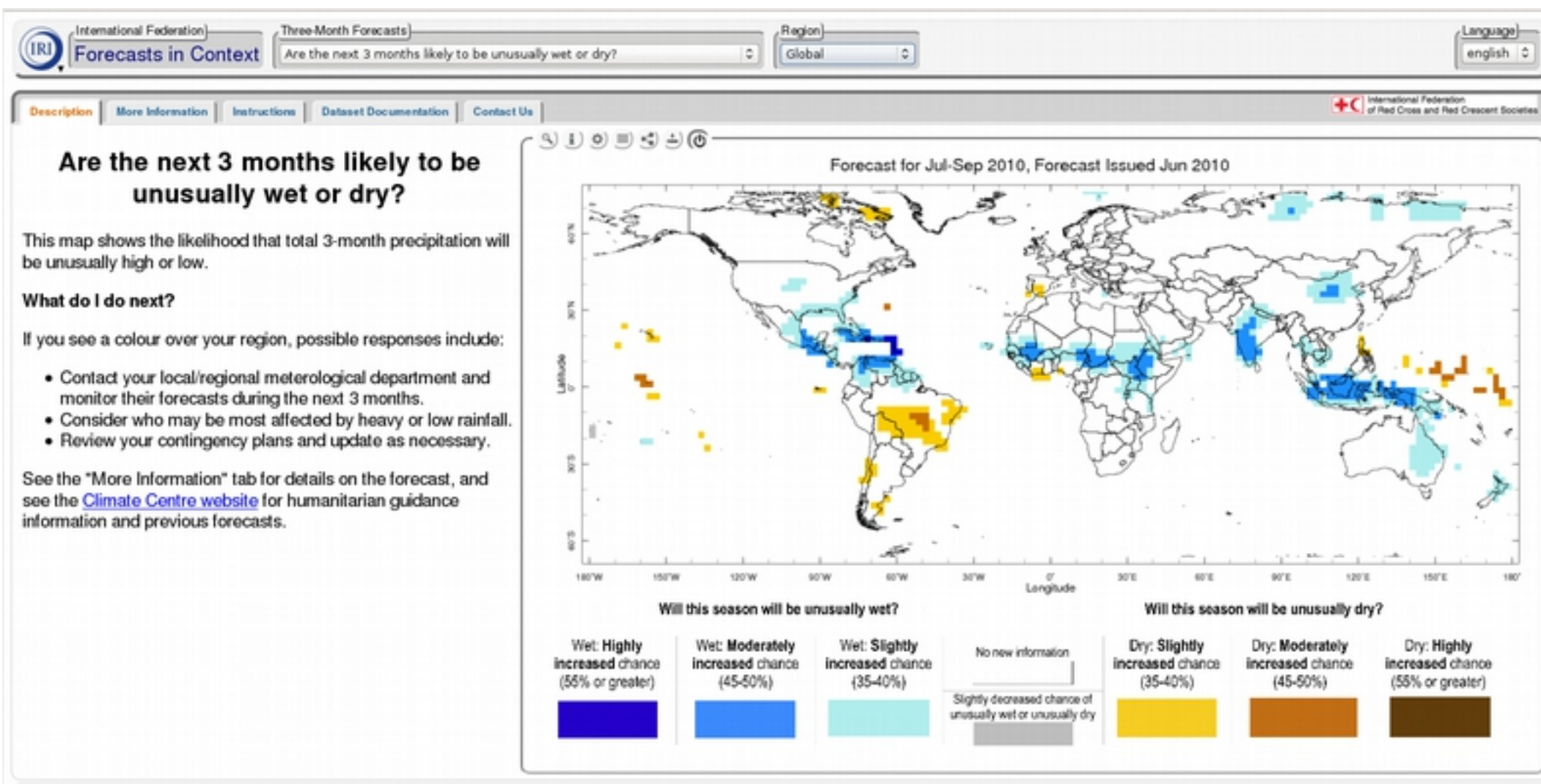
EUPORIAS





[http://iridl.ldeo.columbia.edu/maproom/IFRC/FIC/prcp\\_fcst.htm](http://iridl.ldeo.columbia.edu/maproom/IFRC/FIC/prcp_fcst.htm)

|



## Advancing Renewable Energy with Climate Services (ARECS)

Join the initiative at: [www.arecs.org](http://www.arecs.org)

- ✓ Monthly, seasonal and decadal wind and solar forecasts
- ✓ Provide feedback, register your needs
- ✓ Receive a quarterly, seasonal wind forecast newsletter

### Website



**ARECS**  
Advancing Renewable Energy with Climate Services

HOME ABOUT ARECS PROJECTS NETWORK EVENTS NEWS JOIN US

Monthly to decadal probabilistic climate forecasts for safe and efficient energy management

Business Opportunities

- Climate Variability and Risk
- Wind Forecasts
- Solar Forecasts
- Decision Making Process
- Publications
- Newsletter
- Glossary

**MINIMISE UNCERTAINTY**

Probabilistic climate forecasts predict the future variability and extremes in weather, to minimise uncertainty of renewable power supply and energy demand. Timescales of interest are from one month to decades.

**MANAGE RISK**

By understanding the expected variation of weather resources and its impact on the energy system, improved, proactive and anticipatory adaptation decisions can be made to better manage energy planning and operation risks.

**OPTIMISE STRATEGIES**

ARECS aims to stimulate the use of probabilistic climate forecasts to manage the future risk of renewable power supply and energy demand, by developing a full assessment of wind, solar and temperature predictability alongside tools to effectively analyse the forecasts.

**How could wind power supply and energy demand vary next season?**

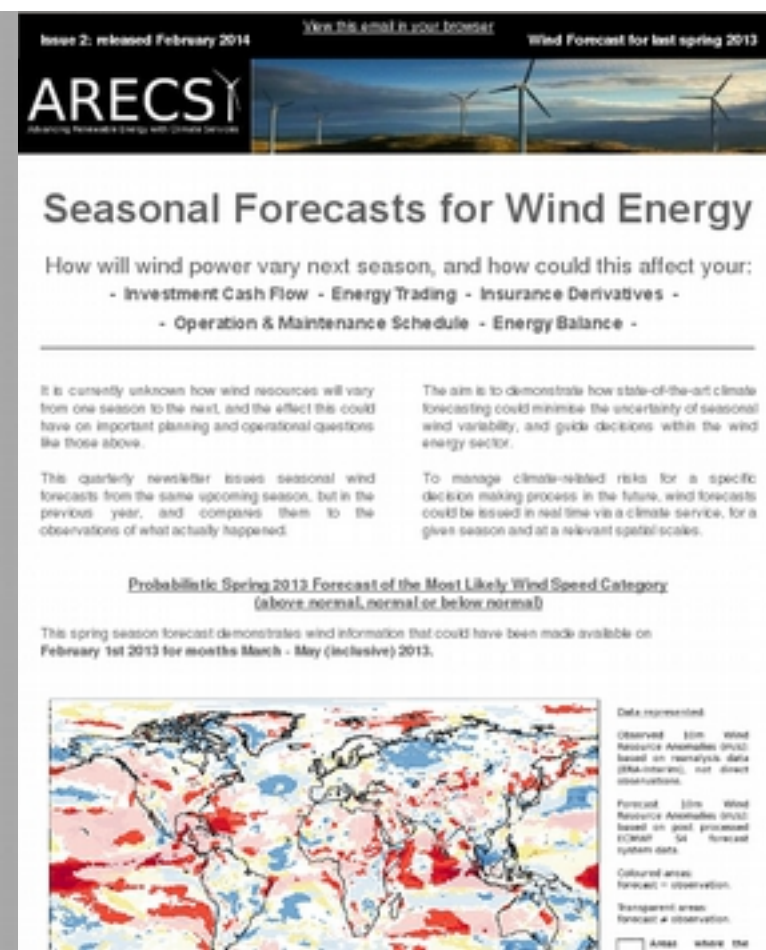
It is currently unknown how wind, solar or temperature resources will vary from one season to the next. The ARECS newsletter aims to demonstrate how state-of-the-art climate forecasting could minimise the uncertainty of future resource variability, and guide decisions within the energy sector.

[Click here to view probabilistic forecast examples](#)

**Could probabilistic forecasts be used to predict meteorological events in the past?**

If your strategies were affected by a variability in climate conditions, please send us details of such events, so that we can assess how well our probabilistic forecasts could have predicted them. Information should include the reference month, season or year, the geographical area, and the observed meteorological conditions.

### Newsletter



Issue 2: released February 2014 [View this email in your browser](#) Wind Forecast for last spring 2013

**ARECS**  
Advancing Renewable Energy with Climate Services

## Seasonal Forecasts for Wind Energy

How will wind power vary next season, and how could this affect you:

- Investment Cash Flow - Energy Trading - Insurance Derivatives -
- Operation & Maintenance Schedule - Energy Balance -

It is currently unknown how wind resources will vary from one season to the next, and the effect this could have on important planning and operational questions like those above.

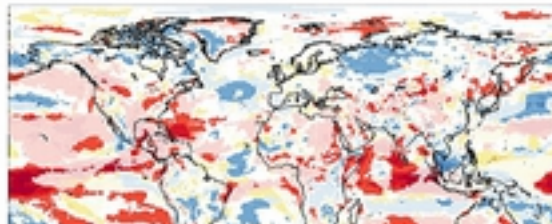
The aim is to demonstrate how state-of-the-art climate forecasting could minimise the uncertainty of seasonal wind variability, and guide decisions within the wind energy sector.

This quarterly newsletter issues seasonal wind forecasts from the same upcoming season, but in the previous year, and compares them to the observations of what actually happened.

To manage climate-related risks for a specific decision making process in the future, wind forecasts could be issued in real time via a climate service, for a given season and at a relevant spatial scales.

**Probabilistic Spring 2013 Forecast of the Most Likely Wind Speed Category (above normal, normal or below normal)**

This spring season forecast demonstrates wind information that could have been made available on February 1st 2013 for months March - May (inclusive) 2013.



Data represented:

- Observed 10m wind Resource Anomalies (m/s) based on reanalysis data (ERA-Interim), not direct observations.
- Forecast 10m wind Resource Anomalies (m/s) based on post processed EC-Earth v3.4 forecast system data.
- Coloured areas: forecast - observation.
- Transparent areas: forecast = observation.
- Areas where the

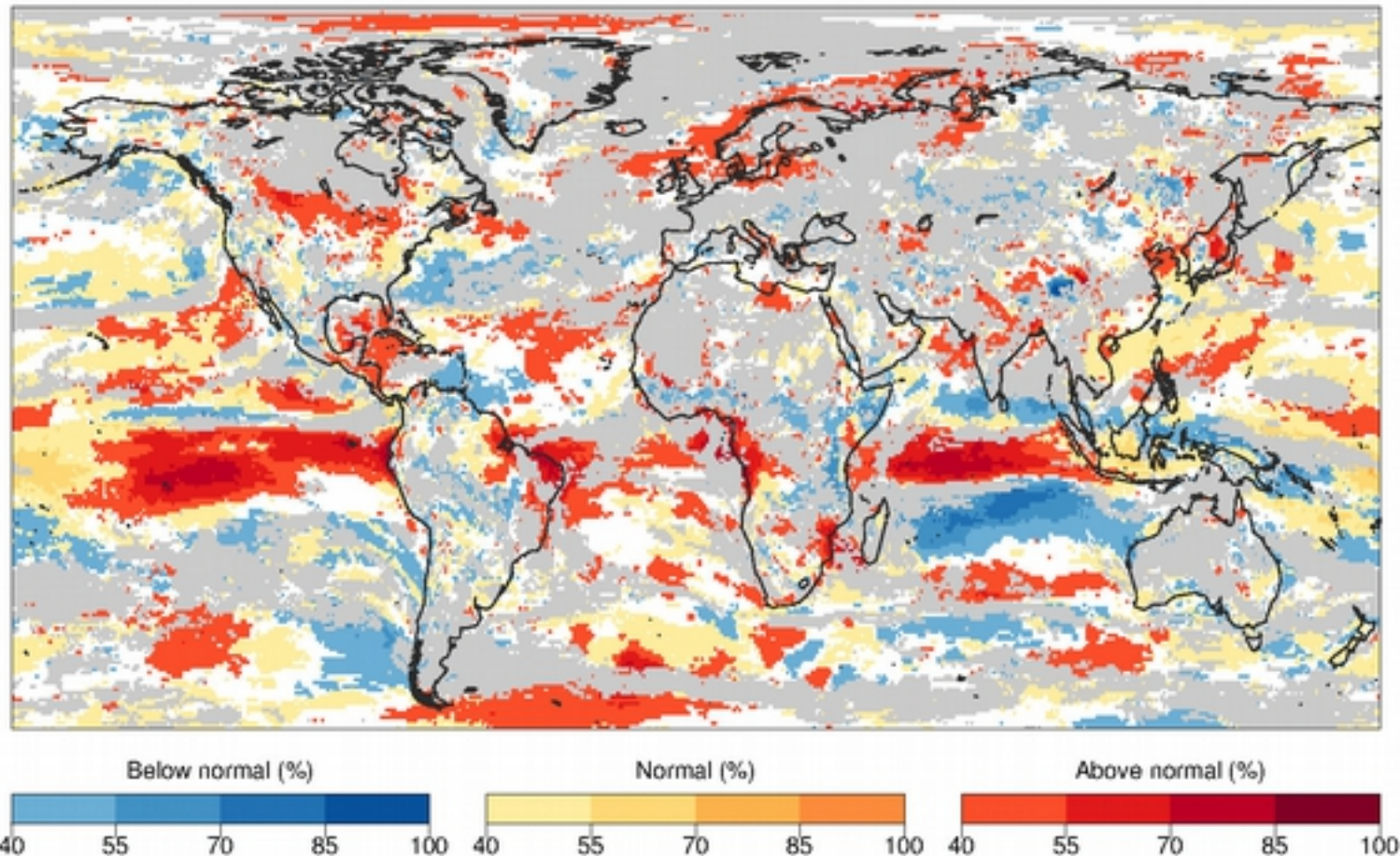


## Most Likely Wind Speed Tercile Winter 2013/14 Forecast

Climate forecast system: ECMWF S4  
10m wind speed observations: ERA-Interim  
1 month forecast lead time

Probabilistic forecast of most likely tercile for 10m wind speed (%)

**December-February (inclusive)** forecast with start date November 1<sup>st</sup> 2013



White colour indicates where forecasts probabilities of all 3 categories are below 40% and approximately equal.  
Grey colour indicates regions without forecast skill.

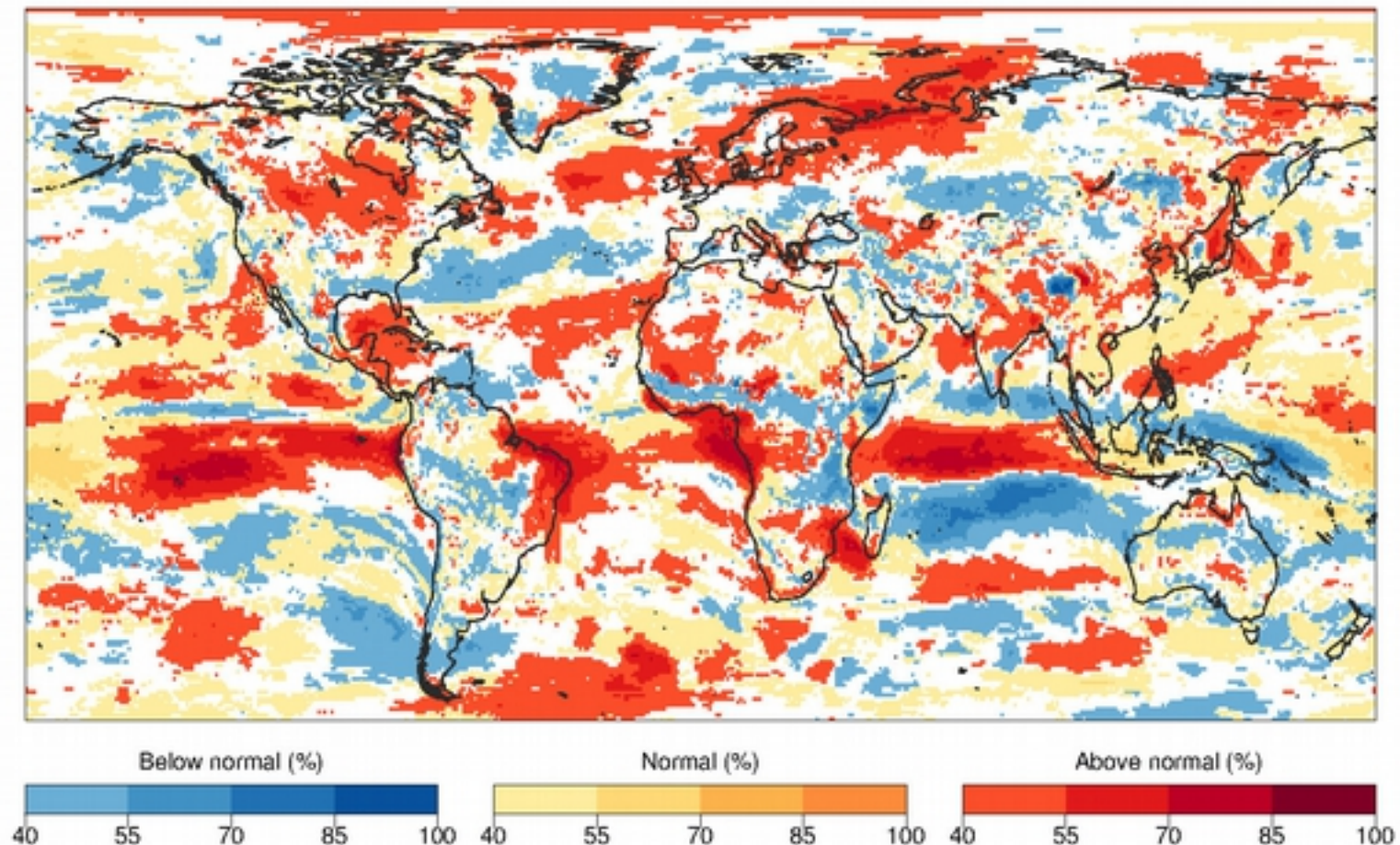


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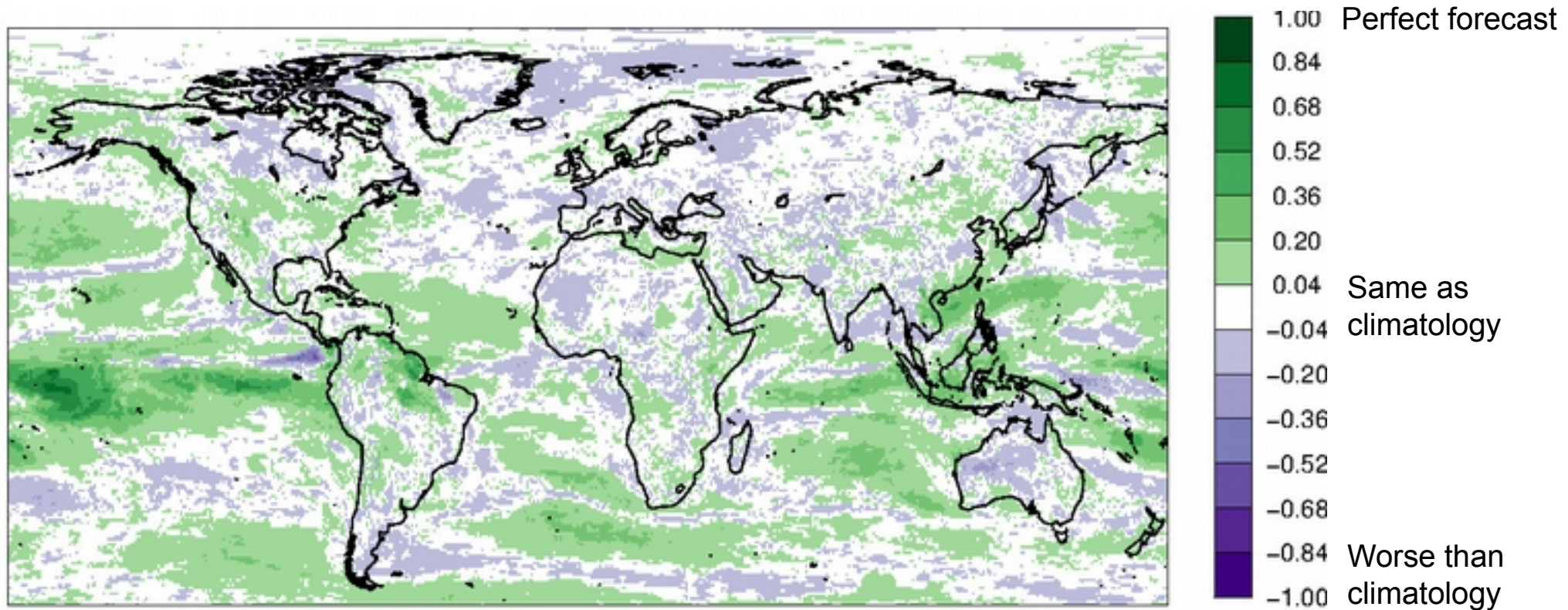


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## Skill Assessment of Winter Wind Forecasts

Climate forecast system: ECMWF S4  
10m wind speed observations: ERA-Interim  
1 month forecast lead time

December-February (inclusive) anomaly correlation, with start date November 1<sup>st</sup> 1981-2013

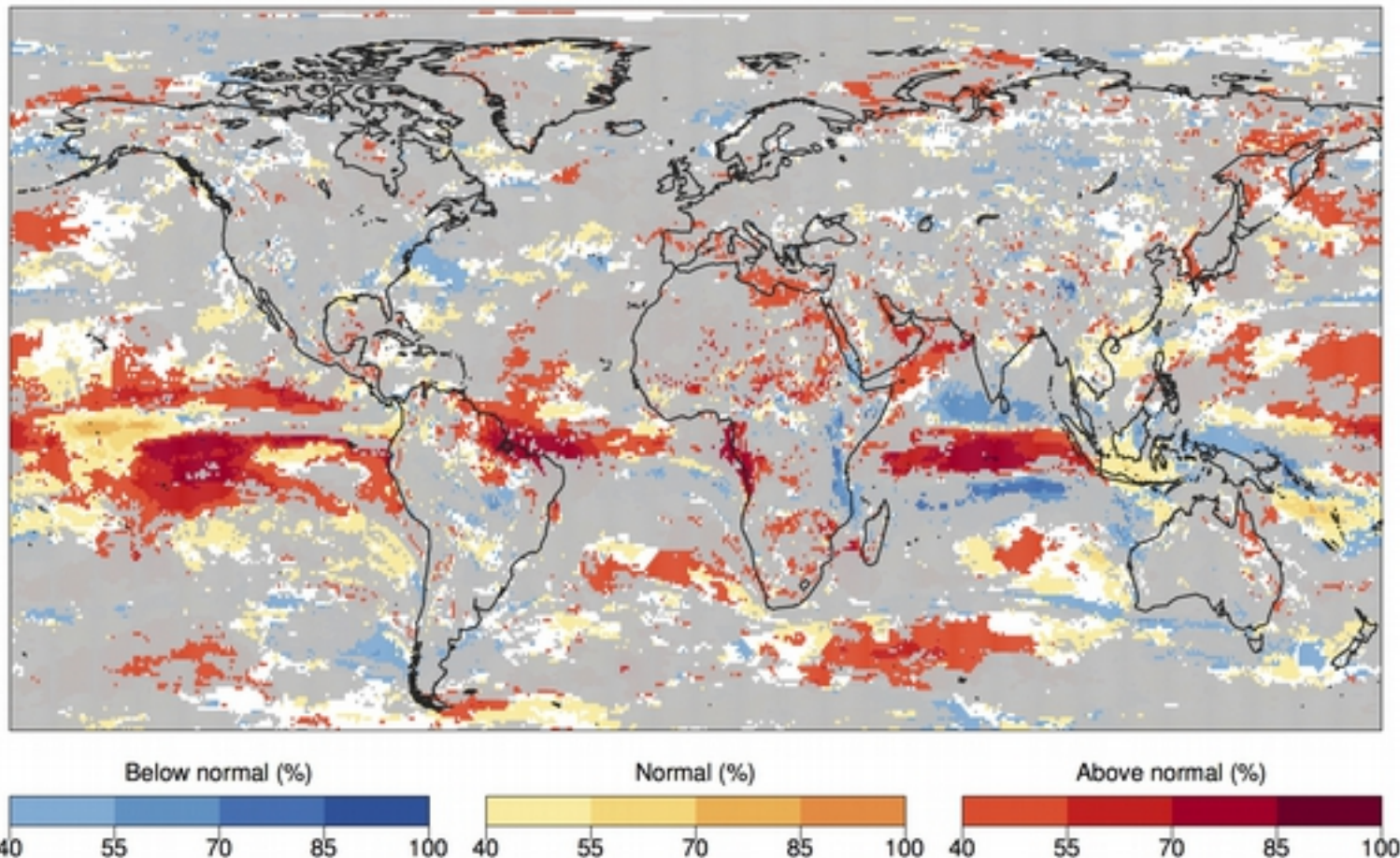




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**December 2013** forecast with start date November 1<sup>st</sup> 2013

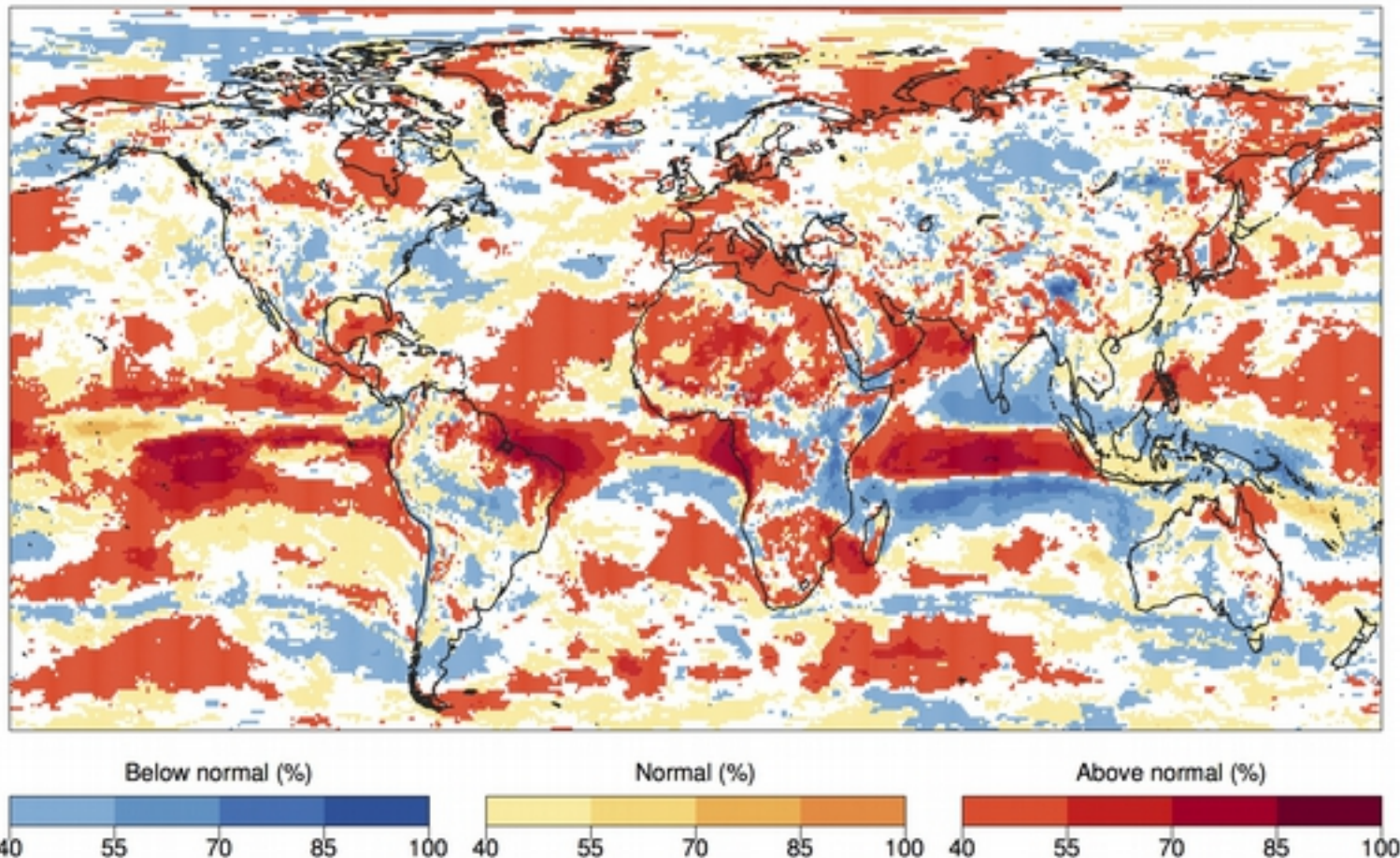


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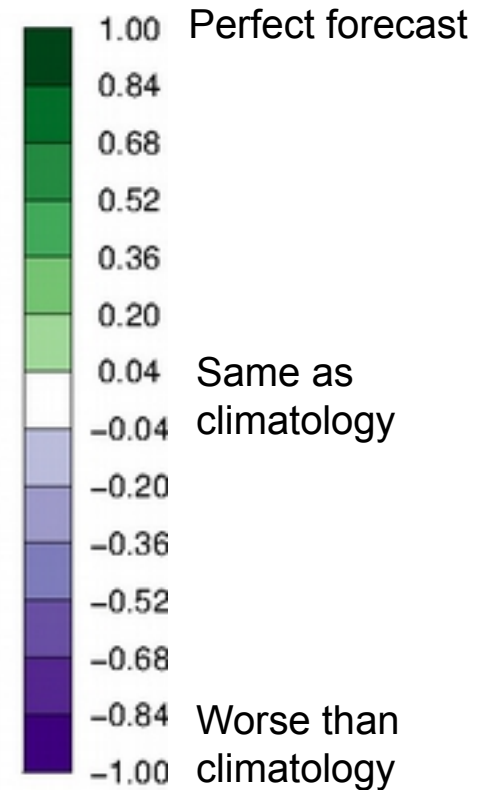
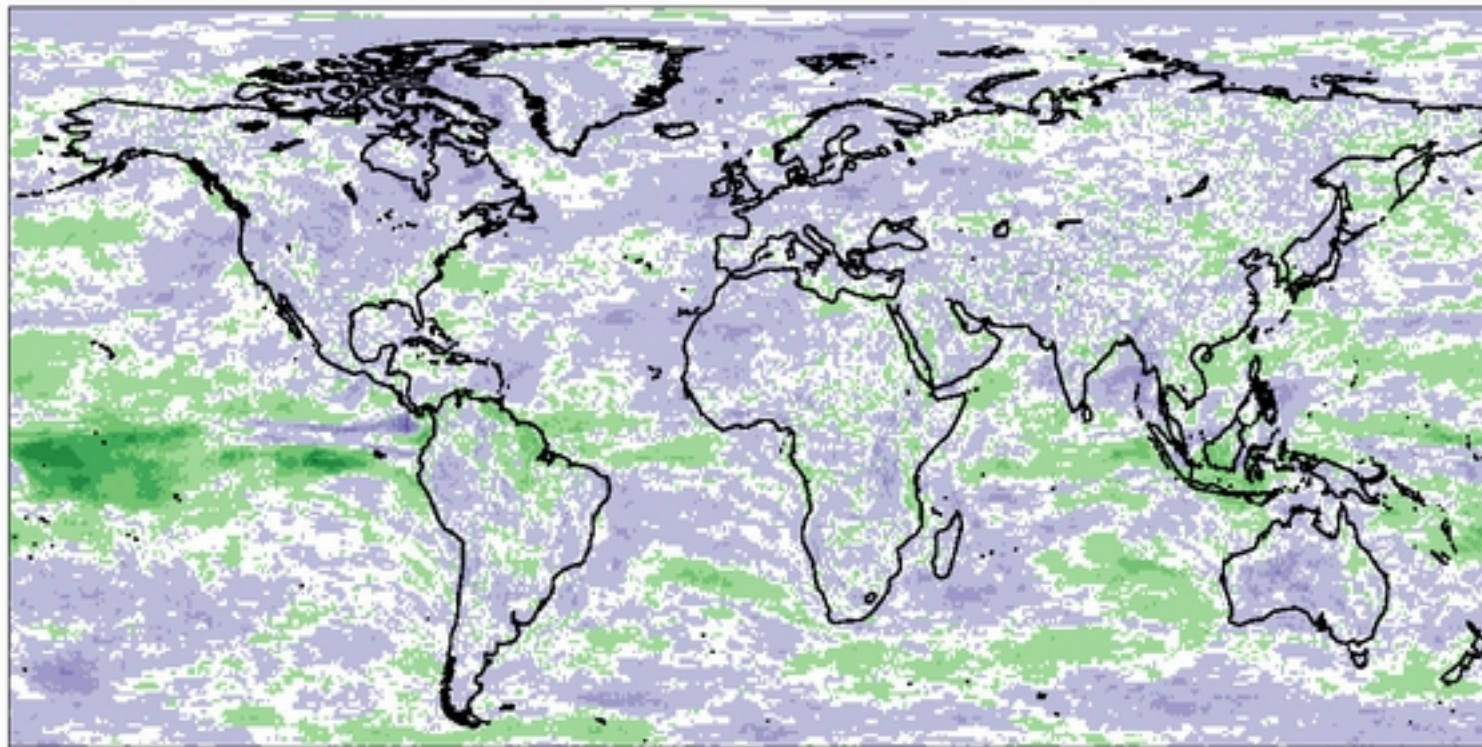
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# Skill Assessment of Monthly Wind Forecasts

Climate forecast system: ECMWF S4  
10m wind speed observations: ERA-Interim  
1 month forecast lead time

December anomaly correlation, with start date November 1<sup>st</sup> 1981-2013



## **Type of questions to be asked:**

- If the average winds in the United Kingdom in January is XX, what is the risk of having higher/lower winds this year?
- If, on average, winds in Holland increase in December, what is the risk that this winter winds will increase earlier or later?
- If usually we have a minimum of XX and a maximum of XX days of winds above 25 m/s in the North of Spain during summer, what is the risk of having less than XX days this year?